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The Lake St. Elevated railway in Chicago is now practically completed from Market St. to California Ave., and work is in progress on the further extension to Garfield Park. Good progress is being made on the large terminal station at Market St., and the way stations are well under way. The structure is of plate girders supported by latticed channel posts, and the stations are modeled after those on the New York elevated railways.

Electric trolley propulsion on the Erie Canal is being experimented upon by both the Westinghouse Co. and the General Electric Co., according to newspaper reports. The Westinghouse Co. is erecting a trolley on a section from Rochester to Westport, N. Y., and the General Electric Co. on a three-mile section from Albany, N. Y., west. The experiments are being conducted to obtain a maximum speed of five miles per hour.

The Poughkeepsie Bridge and the Philadelphia, Reading & New England R. R., a line 180 miles in length, connecting the railways of Pennsylvania and New England, were placed in a receiver's hands this week. This was one of the roads included in A. A. McLeod's unfortunate Reading system. It has a bonded debt of about \$11,000,000 and appears to be sadly in arrears on its interest.

The Chicago Exposition has cost \$23,867,752 to Aug. 7 for construction and administration. The gate receipts to the same date were \$3,447,037, and from concessions \$1,178,546. The daily receipts from all sources are about \$80,000, and the average daily expenses \$15,000, leaving a net daily revenue of \$65,000. Auditor Ackerman, in his condensed balance-sheet of July 31, charges to construction account a total of \$18,819,198; to general and operating expenses, \$4,957,879, and to preliminary organization, \$90,674.

Legal action has been taken by the township of Bloomfield, N. J., to obtain relief from an alleged menace to health caused by the East Orange sewage purification works. These works are located near the Bloomfield township line in close proximity to several houses. Purification is effected by chemical precipitation, supplemented by intermittent filtration on land mostly in grass, as described fully in our issues of Jan. 5 and 19, 1889, Feb. 15, 1890, and Dec. 1, 1892. It is alleged that when the works were put in operation good results were obtained, but that to save expense they are not now operated as was originally intended by their designing and constructing engineer,

Mr. C. Ph. Bassett, M. Am. Soc. C. E., and that the Second River, into which the effluent drains after chemical treatment and filtration, is being so badly polluted as to become a nuisance. It appears from the allegations made that the false economy at the works, if any, lies largely in the use of a deficient amount of chemicals, thus throwing too much work upon the filtration area. Nothing has been advanced, so far as we know, against the purification plant if properly operated, aside from that blind prejudice which is always exhibited when it is proposed to treat sewage in a scientific manner involving visible works instead of discharging it out of sight into a cesspool often in close proximity to a well, or emptying it in its crude state into a stream or other body of water.

Plans for the purification of Park River, at Hartford, Conn., which now receives the sewage of about 40,000 people, have been prepared by Rudolph Hering, M. Am. Soc. C. E. The current of the river being very sluggish, the drainage into it of this large amount of sewage has resulted in a most unwholesome state of affairs, and a movement has been on foot for some time toward its improvement. The plan which has been adopted by the city contemplates the expenditure of \$375,000 in the course of two or three years for the construction of an intercepting sewer to tap all drainage that now goes into the river and carry it to the middle of the Connecticut, somewhat below the mouth of the Park River. It is likely that a beginning will be made early in the autumn, the first section being the main trunk from the Connecticut River to the Park River at Bushnell Park. The estimated expense for this section is between \$80,000 and \$90,000.

The most serious railway accident of the week was a trestle failure on the Atlantic & Danville R. R., near Milton, N. C., at 2:30 a. m. Aug. 16, which caused the death of seven persons. The train was a through passenger consisting of an express car, two coaches and a sleeper. The trestle was about 60 ft. high, and it is supposed that its foundations were undermined by the strong current in the creek, the water in which was about 12 ft. deep. The train was running slowly and the engineer felt the structure settling as the locomotive passed onto it. He opened the throttle and the engine, tender and express car passed over safely. The three following cars went down with the trestle, and the fatalities would have been much greater but for the fact that the train was lightly loaded, there being only 16 persons in the three cars.

The boiler of the Snake River steamboat "Annie Faxon" exploded on Aug. 14 near Almot, Wash., killing or fatally injuring twelve persons.—A boiler mud drum failed in the Lambert & Bishop wire mill at Joliet, Ill., Aug. 19, and two men were fatally scalded.

A firedamp explosion occurred at the Kaiserstuhl coal mine, in Dortmund, Westphalia, Aug. 19, killing 50 persons.

A highway bridge near Wenatchee, Wash., gave way under a light buggy on Aug. 8.—A bridge on the Shore Line division of the New York, New Haven & Hartford, at Fair Haven, Conn., was found to have two cracked floor beams on Aug. 16, and a train was flagged just in time to prevent an accident.—A bridge on the Great Northern Ry., across the Red River at Fergus Falls, Minn., gave way on Aug. 16; the wreck was due to a side collision of a passenger and freight train, which, presumably, knocked down the truss.

A train wrecker who was not familiar with the possibilities of the quick-action air brake rolled a boulder on the track in front of a Pennsylvania R. R. passenger train near Newark, N. J., on Aug. 22. The engineer applied the brakes and the would-be wrecker was astonished to see the train come to a dead stop before it reached the stone he had labored so hard to put in place. He took to his heels, but was overtaken by the fireman and several passengers and was safely lodged in jail.

Two locomotive boiler explosions are reported. A freight locomotive of the Savannah, Florida & Western R. R. burst its boiler while hauling a train near Lakeland, Fla., on Aug. 16. The engineer and fireman escaped with their lives but were seriously injured.—A freight locomotive on the Baltimore & Ohio Southwestern Ry. burst its boiler on Aug. 17 while hauling a train near Rockabill, O. The engineer and fireman and a brakeman were killed.

A steel pulley block for ship rigging and hauling gear is being manufactured by J. L. Pope, of Cleveland, O., and is exhibited at the World's Columbian Exposition. The block is made of two pieces of open-hearth sheet steel stamped to shape, and formed with full round edges to the cheeks, so that the wear on the ropes is reduced to a minimum. Steel straps pass from the sheave bearing to the hook, so that the strain does not all come upon the shell, and a wood filling

is placed between the strap and shell to prevent bending of the shell and to provide a wood bearing for the pin of the sheave. The sheaves are made of two pieces of stamped steel riveted together and are made fast to the pin. It is proposed to electrically weld the two pieces of the sheave, so as to avoid the seam in the center of the groove. A new construction of hook and swivel is used, which allows a universal motion for the hook. These steel blocks are lighter than the ordinary wooden blocks with sheaves of the same size, and it is said that they can be made more cheaply than the latter.

The old Valley Forge camp grounds of Revolutionary fame are being surveyed by the Valley Forge Park Association, recently organized by the State of Pennsylvania. The camp grounds comprise some 500 acres of very rugged country, with over 300 ft. relief, and are being surveyed with the plane table in 10 ft. contours. About one-half of the work is now done. Haupt & Franklin, of Philadelphia, Pa., are the engineers in charge of the work.

Rapid transit schemes in New York City have been shelved for the present owing to the financial depression. The Manhattan Ry. Co. has made a final formal refusal of the terms offered by the Rapid Transit Commission, giving as a reason that "owing to the present disturbed financial condition of the country it is deemed unwise to make any large contracts for extensions."

A rainfall of 1½ ins. in 20 minutes, or a rate of 4½ ins. per hour, was recorded by Dr. Draper, on Aug. 20, at the Arsenal observatory, in Central Park, New York City. This is the heaviest rainfall recorded at this station in its twenty years' existence. From 9:30 a. m. to 3 p. m., or for the entire continuance of the storm, the total rainfall was 2.21 ins., which is the heaviest for the last five years in the same period of time.

The sewage purification works established at Crossness and Barking by the Metropolitan Board of Works (London, England), according to "The Engineer," precipitated 2,007,000 tons of sludge during the year ending June, 1893. The sludge was taken out to sea and deposited 20 miles below the Nore. It contained 89% of water. In addition to the sludge taken to sea 10,000 tons of solid matter were burned. Without the purification works all this matter would have been discharged into the Thames. It is stated that in the first part of August, 1893, whitebait, sturgeon, jelly fish and shrimps were taken with a net at Erith, 15 miles higher up the river than fish had been caught for 20 years. This is considered a proof of the success attending the attempts to purify the river. The purification works at Crossness and Barking have now been in operation about ten months.

Chemical and bacteriological analyses of ice used in London, England, have recently been made in the laboratories of the "Lancet," of that city. The greater proportion of the London ice comes from Norway. Of five samples of imported ice two gave satisfactory chemical analyses, but showed from 400 to 700 colonies of bacteria per cu. cm. of the melted ice, which was considered as very unsatisfactory; the remaining three of the five samples furnished nothing condemnatory upon chemical analysis, but bacteriologically were of doubtful quality. One sample of artificial ice showed no bacteria, but gave indifferent chemical analyses. In our issue of June 29, 1893, there appeared a paper on the "Purification of Water by Freezing," by Prof. T. M. Drown.

It is not generally known that Paris now has a double water supply system, the water for domestic supply being drawn from distant sources and for street washing, boilers, elevators and other purposes from the Seine. We are informed by Prof. Wm. P. Mason, who is now studying foreign water supply systems, that provisions exist for turning the Seine water into the domestic distributing pipes, but that in case such a necessity should arise notice would be given in the daily press, and also special warning by hotels to their guests. Aug. 21, 1892, Professor Mason states, the regular supply was shut off from four arrondissements for 20 days and river water furnished in its place, but the health statistics of the population affected give no indication of the change.

A model of a cantilever bridge which was built in 1662 across the River Kurobe, in Japan, is exhibited in the Japanese section of the Transportation Building, at the World's Columbian Exposition. It was constructed by building out with logs from each side until the space could be bridged, and it had a clear span of 161 ft.

A centrifugal pump in use by the International Dredging Co., of New York city, elevated a 44-lb. boulder while at work near New Baltimore, on the Hudson River, on Aug. 19. The valves were somewhat injured, however, and a strainer is to be placed on the suction pipe to stop solids of more than 10 ins. diameter.

STATIONARY ENGINES AT THE COLUMBIAN EXPOSITION.

(With inset.)

Perhaps there was no single exhibit at the Centennial Exposition in 1876 which attracted so much attention from visitors of every class as the great Corliss engine, which stood in the center of Machinery Hall. It was wellnigh as famous at the Centennial as the Eiffel tower was at the last Paris Exposition, and everyone who wrote anything concerning the Exposition had something to say regarding it. The general public considered it, and for that matter, still considers it, a triumph of mechanical engineering, and it is still a stock illustration among writers and speakers. But notwithstanding its wide fame, the Centennial Corliss engine was of a type which had endured since the days of Watt, and it was practically the last engine of that type to be built in the United States for stationary use.

It will be remembered that the Centennial Corliss engine was of the walking-beam type with vertical cylinders, as shown on our inset sheet this week. This construction was well adapted to the steam engine as it left the hands of Watt, with its parallel motion to keep the piston rod in a straight line, in place of the slides of to-day, and its other peculiar features, such as the direct connected air pump. But with our modern engines a walking-beam between the piston rod and the crank would be a useless waster of power, and the only conspicuous instance of its survival is in the engine in common use on sidewheel steamboats.

Besides this we may also say that viewed in the light of present practice, the Centennial Corliss engine had enormous bulk and weight in proportion to its power. It was very expensive in first cost and cost of erection; and its walking-beams added a great mass of weight to its reciprocating parts, which it is the aim of the modern engine designer to lighten wherever practicable.

Of course, its great bulk with its towering height made the Centennial engine an attractive spectacle to the general public. There is no such conspicuous engine at the Columbian Exposition, which is rather to be regretted. People look at the Allis-Reynolds engine and go away disappointed. As a spectacle it is certainly not to be compared with Corliss' masterpiece; but as a work of mechanical engineering, it is far superior. The useless walking-beams are gone. The flywheel is no longer so many tons of metal doing inertia duty merely, but is made use of as a belt pulley and is even loaded with double work, carrying two belts, one on top of the other. The great engine of the Centennial Exposition now appears as a weak giant. The great engine at the Columbian Exposition is a mighty dwarf.

These two great engines are shown to the same scale on our inset sheet, and their comparative dimensions are given in the accompanying table:

Engine.....	1893. { Quadruple } { expansion. }	1876. Simple.
Cylinders, number.....	4	2
" diameter.....	26, 40, 60, 70 in.	40 in.
" stroke.....	70 in.	120 in.
Flywheel, diameter.....	30 ft.	30 ft.
" width of face.....	76 in.	24 in.
" weight.....	150,000 lbs.	125,440 lbs.
Revolutions per min.....	60	30
Capacity, economical.....	2,000 to 2,500 HP.	1,400 HP.
" maximum.....	3,060 to 4,000 HP.	2,500 HP.
Total weight.....	1,630,000 lbs.	1,360,588 lbs.

The Centennial engine was practically a pair of beam engines driving one shaft, on which was the flywheel. The flywheel had 216 cut teeth on its face, and geared with a 10-ft. spur wheel on the main shaft, 252 ft. long, which ran across the building and drove four lines of longitudinal shafting by bevel gears. The two walking beams were each cast solid in one piece, and weighed 24,640 lbs. each. They were 27 ft. long and 9 ft. deep at the center. The Columbian engine has a Reynolds patent condenser, with independent air pump 36 ins. diameter by 16 ins. stroke, driven by a steam cylinder 16 x 36 ins.

A striking contrast between the Centennial and the Columbian Exposition is in the use of power. At the Centennial, the great Corliss engine developed about 1,400 HP. and furnished practically the sole motive power for Machinery Hall. At the Columbian Exposition, engines are at work having a total capacity of 24,000 HP., of which 7,000 HP.

is used for driving the machinery exhibits and 17,000 HP. is applied to a use which was not dreamed of in 1876 in connection with the steam engine, namely, the generation of electricity. Probably these figures do not unfairly represent the proportion between the current demand for steam engines for power and the demand for electrical purposes. In fact, the numerous applications of electricity instead of doing away with the steam engine, as the general public is prone to believe, have afforded a new and large market for the steam engine and given a great impetus to improvements in its design.

It is true that a large number of steam engine builders are unrepresented at the Exposition; but among the 40 odd builders who have engines in operation, there is a sufficiently good representation of current practice in steam engine design to make the exhibit worth considerable study. A list of the engines in the power plant with their makers and principal dimensions was given in our issue of July 20.

Horizontal Engines with Corliss Valve Gear.

The general arrangement of engines of this class for sizes above 1,000 HP. is with a central flywheel (serving also as a belt wheel), and cranks on each side set at right angles. The cylinders vary, according to the power desired, from the cross-compound with the high-pressure cylinder on one side and the low-pressure on the other to the Allis quadruple-expansion with its two tandem cylinders on each side. Of course, this quadruple-expansion engine represents a practice somewhat in advance of present demands, and to work with best economy requires a higher boiler pressure than most mill managers are accustomed to. Current practice in four-cylinder Corliss engines is better represented by the Fraser & Chalmers triple-expansion engine, which has two low-pressure cylinders, or by the duplex tandem compound engines, of which there are several examples.

Practically all two-cylinder mill or electric light plant engines are nowadays built compound, and of the Corliss type the cross-compound appears to be gaining in favor over the tandem with both cylinders working on one crank, for, while the former takes up more room and is more expensive to build, it gives a much more even turning movement, and thus admits of closer regulation, and the cylinders are more easily got at for repairs.

The use of the flywheel as a band wheel appears to be almost universal. There are only two horizontal engines on exhibition in Machinery Hall which have the old-fashioned solid rim balance wheel. One is an Allis duplex cross-compound which has a 10,000-light Westinghouse alternator mounted directly on its main shaft, so that it has no need of a belt wheel. The other is a small engine in the Mexican exhibit.

One objectionable outgrowth of the use of the flywheel as a belt pulley, and the consequent widening of its face which has occurred, is the very large span between bearings of the main shaft. In fact designers appear to pay little attention to keeping the span of the main shaft as narrow as possible; and at least one recent shaft breakage was traceable to the alternating bending strain to which one of these long span shafts was subjected. To show the bending strain which is put upon these shafts, the big Allis engine shaft is 10 ft. 4 ins. between bearings. It is 19 ins. diameter in the bearings and 21 ins. at the wheel fit. The load upon it consists of the flywheel weighing 150,000 lbs., and the pull of the two belts which ride on it, 72 ins. and 71 ins. wide. The flywheel face is 76 ins. wide, so there is 2 ft. clearance on each side between the rim of the wheel and the bearing. The only obstacle to reducing this clearance is the space taken up by the eccentrics and the governor belt; but it is not evident why 2 ft. space on each side is necessary for these.

We mention this engine merely as an illustration. It is far from being the worst sinner in this respect in the Exposition. A tandem compound engine, shown by the Golden State & Miners' Iron Works, of San Francisco, has a main shaft 6 ft. 8 ins. between bearings, and the outer bearing is at least 30 ins. from the flywheel hub, with no eccentrics or other machinery whatever to prevent reduction of the space.

In frame construction the familiar Corliss type is followed pretty closely. The best practice appears to be to make the offset back of the connecting rod as small as possible, and an effort is made to combine lightness with stiffness and strength by casting frames of the hollow tubular or the box girder form. With the tubular frame, bored guides are generally used. They are probably cheaper than any form of built guides, and they cannot spring, as light wrought iron guides are apt to. On the other hand, all adjustment for wear must be made on the crosshead, and it is not easy to secure a light cross-head construction. It must be said, however, that most makers appear to pay little attention to this point.

The example of high speed engine builders and the demand for closer regulation for electric purposes have led to some increase of speed in Corliss engines. The Allis engine has a piston speed of 720 ft. per minute. The Fraser & Chalmers triple-expansion 1,000-HP. engine runs at 645 ft. piston speed. The Bass Foundry & Machine Works and Lane & Bodley, of Cincinnati, each show a 350-HP. cross-compound running at 515 ft. per minute. The Sioux City Engine Works have a single cylinder 400-HP. Corliss with 4-ft. stroke, making 560 ft. per minute piston speed, and another single cylinder Corliss by the Bates Machine Co. is rated at 576 ft., though for the line shaft work, which it is doing in the Exposition, it is held down to 512 ft. Of course, these are not high piston speeds, compared with marine or locomotive practice, but they represent an advance over old-time Corliss customs. One looks to see this increase in speeds followed by some changes in the design of the machine better adapting it to resist high speed strains; but such changes are apparently few. Builders of short stroke fast running engines have generally adopted the flat connecting rod, as the locomotive builders did before them many years ago. But the Corliss engine builders still stick to the round connecting rod, which can be turned up in the lathe, tapering it from the middle each way, to provide for the bending strain.

One is inclined to question, by the way, whether it is necessary to place the crankshaft quite so far away from the cylinder as it is on some of these Corliss engines, especially those of the smaller sizes. Of course, a shorter connecting rod means more work thrown on the cross-head and guides, but it also means a stiffer and lighter rod, a shorter and stiffer frame, with less weight and less space taken up. Really, when one compares a modern short stroke high speed engine, or one of the vertical direct acting type, with a Corliss (especially a tandem Corliss) the latter appears like a very long drawn out machine. Will not the change of the future in the Corliss engine be in the direction of a somewhat quicker stroke, and a shorter connecting rod? The quicker stroke will permit a smaller flywheel, and will help in the governing, and the smaller flywheel and shorter connecting rod will each reduce the length of the machine. Then, if not before, the flat rod may be expected to replace the round rod. If made on a modern milling machine, it need be little, if any, more expensive.

In the arrangement of tandem cylinders the most common practice seems to be to place the high-pressure cylinder in the rear of the low-pressure cylinder. Whichever arrangement is adopted, practically all Corliss makers leave space enough between the cylinder ends for the heads and pistons to come out without disturbing the cylinders or the alinement of the engine. Most makers have some provision for the relief of water in the cylinder. The commonest plan probably is to permit the valve to lift, in case of over pressure.

A large book might be written on the various styles of Corliss valve gears. The aim of each designer appears to be to secure what in his opinion is a proper distribution of steam, to get as much durability as possible in the disengaging portions of the gear, and last, but not least, to make something different from every other fellow. Simplicity is thrown quite out of the account, for the engine purchaser looks for ingenuity, not simplicity, in a Corliss valve gear.

The main indictment which the electrical people have brought against the Corliss engine is that it

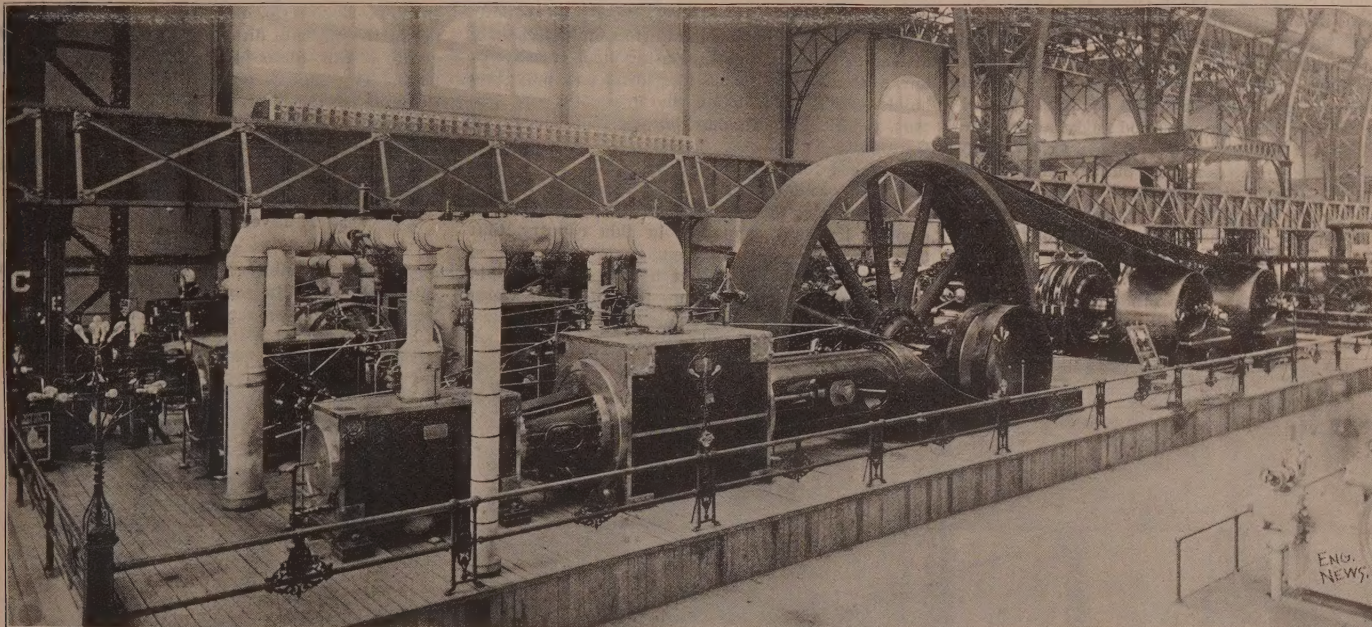
does not regulate closely with a variable load; and much attention has been paid by engine designers to remedying this. Various forms of new governors have been tried, but the two-ball type is still the most common. On multiple-cylinder engines the governor is sometimes made to regulate the point of cut-off in all the cylinders, and best practice gives a much wider range of cut-off, to correspond to the extreme changes of load which occur in electrical service, than was formerly

High Speed-Horizontal Engines.

There are more engines of this class in the Exposition than any other, and it is interesting to note that this type of engine owes its development very largely to the demand for engines for dynamo driving, to which we have referred to above, and hence is practically an outgrowth of very recent years. The typical engine of this class is a center-crank, short stroke machine, mounted on a single base casting. The smaller sizes have single

are generally much smaller and their cylinders are built with greater diameter in proportion to their length. Makers generally pay great attention to lubrication and provide automatic oiling appliances and ample bearing surfaces. Most makers, too, exercise considerable care in balancing their machines.

It may be of interest to discuss the principal features of engines of this class which have given them an advantage over the Corliss type in



REYNOLDS CORLISS QUADRUPLE-EXPANSION ENGINE IN WORLD'S FAIR POWER PLANT.

Rated capacity under economical load, 2,000 to 2,500 HP.; maximum capacity, 3,000 to 4,000 HP.; cylinder diameters, 26 ins., 60 ins., 70 ins.; stroke, 72 ins.; speed, 100 revs. per minute (= 720 ft. piston travel); fly-wheel, 30 ft. diameter, 76 ins. face; weight, 150,000 lbs.; speed of rim, 5,655 ft. p. r. minute; belt widths, 71 ins., 72 ins.; capacity of the two Westinghouse alternating dynamos driven by engine, 30,000 incandescent 16 c. p. lamps. Independent jet condenser and air pump, Reynold's pattern, air and steam cylinders, each 16 X 56 ins. All cylinders steam jacketed on barrels with steam at boiler pressure. Tubular reheating receivers between cylinders. Total weight of engine, 315 tons. Edwin Reynolds, M. Am. Soc. M. E., designer.

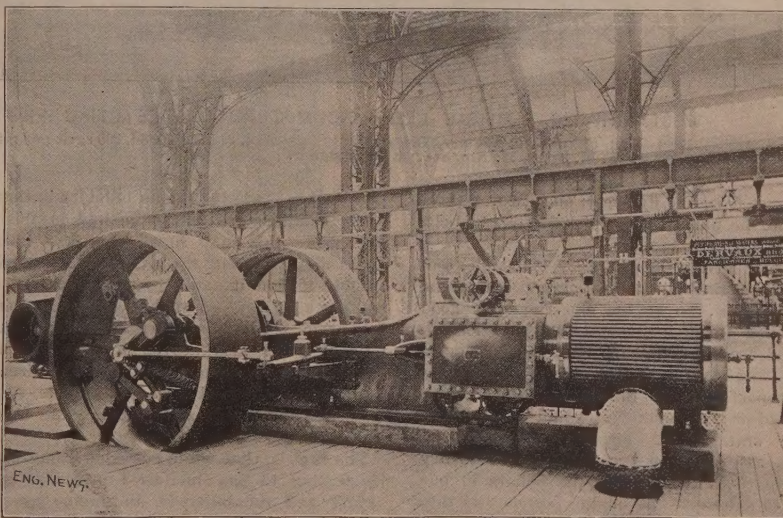
allowed. The sensitiveness of the governor has also been increased by speeding it up, and the Sioux City Engine Co. has adopted the novel plan of supporting the governor on a ball bearing, so that it runs without oiling and with very little friction.

Automatic stop motions are fitted to all engines with belt driven governors, to stop the engine in case the governor belt breaks and the governor balls fall down to the limit of their travel. In ordinary practice the engineman places a catch under this stop motion when about to shut down and should remove it when he starts up again. In case he forgets to do so the stop is, of course, inoperative and the engine may run away if the governor belt is thrown off. The Bates Machine Co. has an automatic attachment on its stop motion catch to prevent such a mischance occurring. The engineman, when he stops his engine, puts the catch in position to prevent the valve gear from unhooking as the governor balls settle down, and then gives it no further attention. When he starts up again the catch is removed automatically. The Sioux City Engine Co. goes this device one better. The catch which holds the stop motion is operated by a Bourdon gage, and the release of pressure in the steam chest when the throttle is closed throws it into position as the governor balls settle down. On starting up the catch is thrown out as soon as pressure is let into the steam chest.

Comparatively few of the Corliss engines on exhibition are steam jacketed; but the best practice, nevertheless, is to use steam jackets on the high-pressure cylinder and tubular reheating receivers in passing the steam from one cylinder to the next. Whether jacketing should be extended to the lowest pressure cylinder of a series is a disputed question, of which the best solution, perhaps, is to take steam for it through a reducing valve. Of course, all these devices add something to the cost and complexity of the engine, and a very large class of purchasers want the simplest and cheapest engine, regardless of other considerations.

cylinders and the larger sizes are compounded, with the high-pressure cylinder in the rear of and close to the low-pressure cylinder and supported by it. Thus the high-pressure cylinder projects from the rear of the machine like the cylinder of a gas engine. The valve is driven by an eccentric or by a short outside crank and the cut-off is regulated

electric lighting and electric railway work. First, is the matter of regulation. The load on an engine in electric railway service varies with astonishing rapidity between wide limits. Nine-tenths of all the cars on the line may happen to stop or start simultaneously, or a circuit breaker may blow out and the whole load goes off. In electric light-



STEARNS MFG. CO.'S TANDEM COMPOUND HIGH-SPEED ENGINE IN WORLD'S FAIR POWER PLANT.

Rated capacity, 600 HP.; cylinder diameters, 19 and 31 ins.; stroke, 24 ins.; speed, 165 revs. per minute (= 660 ft. piston travel) two belt driven Mather dynamos on power circuit, 225 K-W. capacity each.

by a shaft governor. The piston valve is common, but double-ported slide valves and riding cut-off valves are also seen. Steam jacketing is the rare exception, and as the governor has no chance to become disconnected, automatic stop motions are not used, except rarely on the larger sizes.

Although the engines are called high-speed engines, their piston speed is not, as a rule, above 600 to 700 ft. per minute, or no more than that of the large sizes of Corliss engines. But they

ing service close regulation of speed is essential to keep the light steady and insure long life to the lamps. Now, if two engines have the same piston speed, but one makes twice as many strokes per minute as the other, the short stroke engine governor evidently has a chance to regulate the steam supply to correspond to the work twice as often as the governor on the other engine. In addition to this, the flywheel governors used on the high-speed engines respond much more quickly to changes in

speed than the pendulum-ball governors used on the Corliss engines. If the engine makes a sudden jump, the flywheel governor must go with it, but the ball governor may slip or stretch its belt and be a little sluggish to respond to the change of speed.

Again in the matter of cost, if two engines have the same size cylinder, but one makes twice as many revolutions as the other, it is evident that the high-speed engine generates twice the power for the same first cost. The valve motion of most engines of this class is simpler and much cheaper than the Corliss. The rotative speed is so much higher that a much smaller and lighter flywheel gives equally good regulation and equally high belt speed. Until a very recent period no dynamos were in the market capable of absorbing over 100 HP. As the Corliss engine is seldom built in small sizes, it was necessary in driving an electric lighting station by Corliss engines to belt from the flywheel to a jackshaft, and then from pulleys on this to the dynamos. This meant an increased first cost and a constant loss of power. With the high-speed center-crank engine, on the other hand, of 100 to 400 HP. capacity, dynamos could easily be driven

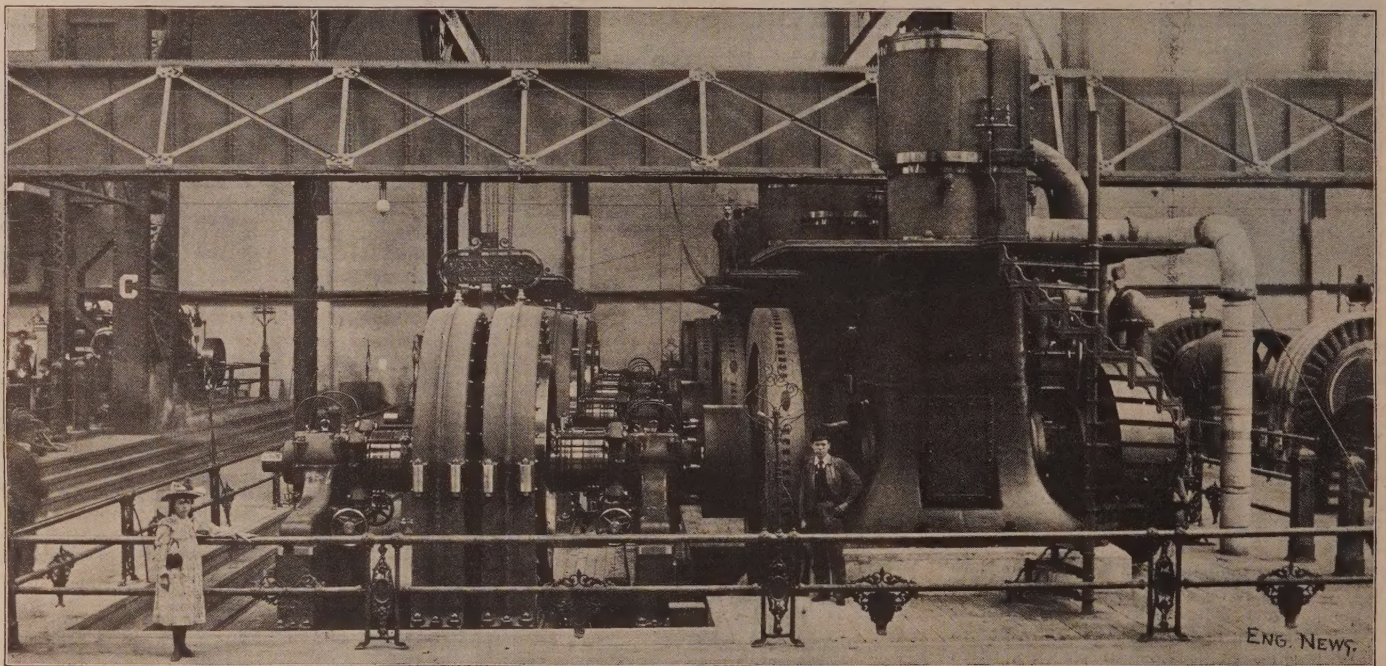
mits; but unfortunately builders of high-speed engines, or some of them, have catered too much to the demand for low prices. Higher speed means increased strains, especially on reciprocating parts, and lighter and stronger pistons, crossheads and rods are demanded on a high-speed engine than on a low-speed. The high-speed builders have made many improvements, such as replacing the round connecting rod with the flat locomotive type rod, substituting built-up guides and light crossheads for bored guides and heavy crossheads, and balancing rotating parts which the Corliss builders hardly attempt. Most of them are using steel crossheads, but a thorough canvass has developed only two builders in the Exposition who are using steel pistons, the Buckeye Engine Co. and F. Schichau, of Germany.

The need for better material in pistons of these high-speed engines is illustrated by a recent statement made by the engineer of one of the largest electric lighting companies in this country that breakdowns of high-speed engines had become so serious in his stations, that he proposed to build bulkheads around his engines to protect the workmen from flying cylinder heads and broken pistons.

those obtained by the releasing valve gear which may be said to form the distinctive feature of Corliss' invention, and to surpass the Corliss type in the matter of regulation, durability, simplicity, etc. The Russell engine, for example, admits steam through a double-ported slide valve, and exhausts through valves operated by a Corliss gear. The Atlas Engine Works, of Indianapolis, have a four-valve gear in which the valves are operated by a cam motion to secure their proper movement. The Buckeye Engine Co. has a riding cut-off valve moving in the opposite direction to the main valve and giving a full admission and quick cut-off and release. The engines exhibited by B. W. Payne & Co. and by the A. B. Farquhar Co. also deserve mention, as their designers have attempted to secure good steam distribution by using independent exhaust valves, but have discarded the releasing feature of the Corliss gear.

Vertical Inverted Cylinder Engines.

Compared with the array of makers of horizontal engines the exhibitors of engines of what may fairly be called the most modern type are few in number; but they make up for that by the enviable



WESTINGHOUSE VERTICAL STEEPLE-COMPOUND DOUBLE-ACTING ENGINES IN WORLD'S FAIR POWER PLANT.

Nominal capacity, 1,000 HP.; cylinder diameters, 21½ and 57 ins.; stroke, 22 ins.; speed, 200 revs. per minute (= 733½ ft. piston travel). Each engine direct-connected to 15,000-light Westinghouse alternator. F. M. Rites, M. Am. Soc. M. E., designer.

by belts direct from the flywheel; one, two or three pulleys could be put on the main shaft, and belts could be run single or tandem.

Still another advantage of the typical high-speed moderate-size engine lay in the subdivision of the power. Of course, no engine can run with good economy when too lightly or too heavily loaded. With a half dozen engines of moderate size in an electric lighting station, the number running could be kept proportionate to the demand for current and a breakdown of one engine would not seriously affect the station. In running manufacturing plants, too, there has been a noticeable tendency in recent years to concentrate the boilers in one plant, but to subdivide the engine power, and thus save in the cost of belts, pulleys, shafting and hangers, and also in the loss of power by friction in transmission, a loss which was often more than sufficient to offset the superior steam economy of one large engine over several smaller ones.

With all these points of advantage it is no wonder that the high-speed engine has won hosts of friends, and that its numerous builders have found profitable markets. But there is another side to the question, and at the present day there is apparently somewhat of a reaction among steam users in favor of engines of more moderate speed. That increased speed means reduced steam consumption, other things being equal, every one ad-

An excuse made by engine builders is that reliable steel castings are not to be had in this country; but while this may have been the case a few years ago, it is not the case now. By taking the trouble to find it and prove its quality, good steel can certainly be had in this country, as our record in armor-plate and armor-piercing projectiles proves. It is also proved by the extensive use which these very engine builders are already making of steel. Forged steel crankshafts, piston rods and connecting rods are the rule, and so are steel crossheads.

The fact is, that while customers may not always be willing to pay increased prices to secure it, safety and reliability in an engine are worth a great deal. The record made by some of these high-speed engines in this respect is certainly remarkable, but some of them, on the other hand, prove very "cranky" in service, and it is this, perhaps, as much as anything which has led to somewhat of a reaction in favor of moderate speed.

Other Classes of Horizontal Engines.

Besides the engines with Corliss valve gear and the high-speed engines, there is another class of engine which deserves some mention here. Notwithstanding the prestige which attaches to the name of Corliss, there are other makers who have in recent years won wide reputation, who claim to secure equally good results in steam economy with

reputations they have made and their excellent exhibits. The vertical inverted cylinder engine has by many years' hard service on shipboard proved its superiority in compactness, lightness and steam economy. The last few years have given it an equally good record when doing duty on shore. The vertical engine has the considerable advantage over the horizontal that the weight of the reciprocating parts is not carried on sliding surfaces to cause unequal wear upon them. In effect, the whole weight becomes merely so much added force to aid the down stroke and retard the up stroke, and in the case of multiple-expansion engines the weight of one set of parts balances that of another.

It is interesting to conjecture why the vertical direct-acting engine has been so slow in developing. Perhaps one reason is the hold which the long connecting rod retained upon engine designers. It would be ridiculous, of course, to set a long stroke, long connected Corliss engine on end; and it was not till the invention of the propeller forced marine engine designers to adopt a short stroke and short connecting rod, notwithstanding previously accepted notions, that the real merits of the vertical type in compactness became apparent.

It is to the genius and enterprise of Westinghouse in this country, and Willans, in England, however, that the popularity of the vertical engine for general service is largely due. Both these

engineers recognized that the height of the vertical engine was a chief drawback to its popularity; and by perfecting a single acting type of engine, they were able to so shorten the connections between piston and crank as to reduce their engines to a symmetrical height, and make them as easy to erect and repair as a horizontal engine.

Of the Willans engine a half dozen are on exhibition at the Exposition, varying in size from 50 to 365 HP. Remarkably low steam consumption records are claimed for this engine; but one is inclined to investigate them pretty closely on learning that the engine has a throttling governor. The American steam user is now so well educated to the value of an automatic cut-off engine that it is questionable whether he can be made to pay the same price for a throttling engine.

The Westinghouse engines, both simple and compound, are now familiar to most engineers; but the new 1,000-HP. double-acting compound which was designed expressly for work at the Exposition

double its rated capacity. The engine of this type in the Exposition which deserves most praise, however, is the 1,200-HP. triple-expansion engine exhibited by F. Schichau, of Elbing, Prussia, carrying a 1,000-HP. Siemens & Halske dynamo directly on its main shaft. The quiet, steady working and the combined lightness and stiffness of the machine win praise from every observer. The base plate of this engine occupies a space only 9×18 ft.; and its height to top of cylinders is about 16 ft.

This type of engine has come into extensive use in Germany, and is rapidly being accepted in this country as the coming type for electric service where large amounts of power are desired and space is a consideration of importance.

Novelties in Small Steam Engines.

This class is surprisingly small in the Exposition, when one considers how many peculiar types of engines are every year brought forward. The An-

TEST OF ALLIS PUMPING ENGINES AT THE CHICAGO WATER-WORKS.

Complete duty and capacity tests were made last month on three high-duty pumping engines built by E. P. Allis & Co., of Milwaukee, Wis., and in service at the Fourteenth St. station of the Chicago Water-Works. The engines are triple-expansion and direct-acting with vertical inverted cylinders, each piston rod being connected to the plunger of a single-acting pump. The reciprocating parts are made heavy enough to absorb the work done by the steam on the up stroke, and give it out on the down stroke. The movement is equalized by cranks and flywheels, the cranks being set 120° apart. The pumps deliver directly into the force mains with no stand-pipe to equalize the pressure, and the cut-off in the high-pressure cylinder is controlled by a governor. The cut-off in the other two cylinders is adjustable only by hand. The engines are fitted with Corliss valve gear on all cylinders, the valves being located in the cylinder heads. All the cylinders are steam jacketed, and reheating receivers are placed on each side of the intermediate cylinder. The steam for the low-pressure jacket and for the lower receiver is reduced to 45 lbs. pressure, the other receiver and the jackets on the other cylinders have boiler pressure steam. The air pump, the boiler feed pump and an air compressing pump for charging the pump chamber are driven by an arm on the low-pressure plunger.

Steam is furnished to the engine by a battery of nine boilers. They are of the return tubular type, the fire being under the boiler, and the gases passing back through the tubes and over the top of the shell to the uptake. Six of them are fitted with the Hawley down-draft furnace (illustrated and described in Eng. News, Jan. 30, 1892).

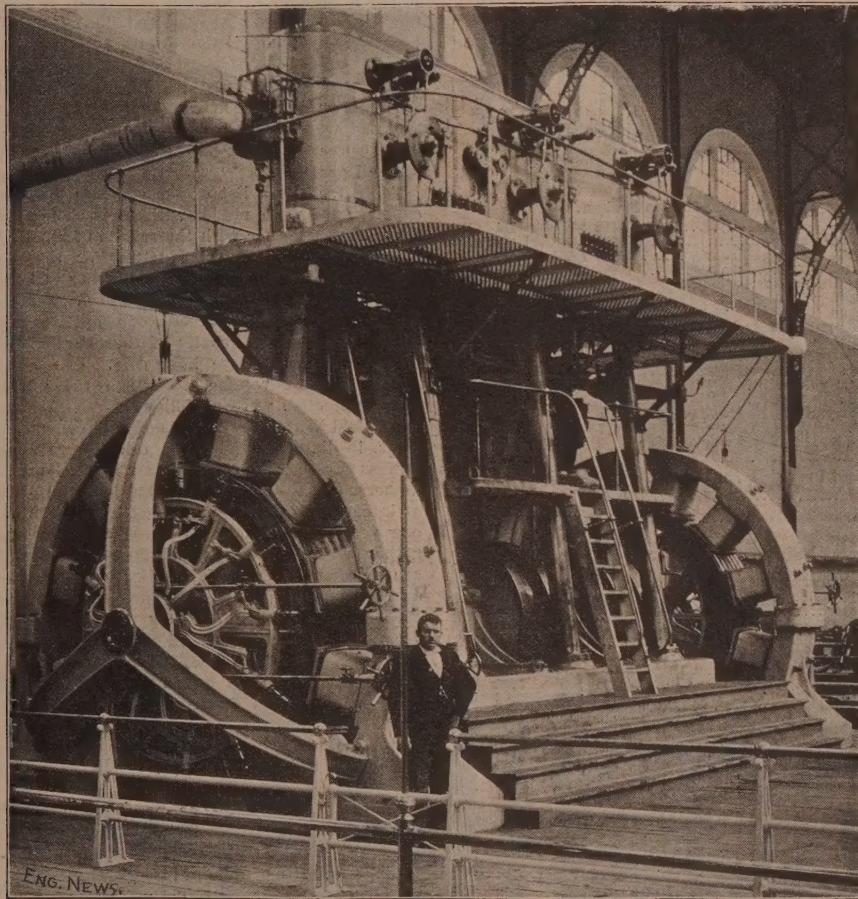
The contract between the city of Chicago and the builders specified that the engines should show a duty of at least 125,000,000 ft.-lbs. per 1,000 lbs. of feed water when pumping at the rate of 15,000,000 U. S. gallons per 24 hours against a head of 125 ft., with a piston speed of 162 ft. per minute, and a boiler pressure of 120 lbs. The duty test was unusually long—48 hours. The three engines were run with four boilers only, burning Hocking Valley bituminous coal. The engines had run about five months at the time of the test. The delivery of the engines was measured by plunger displacement and no allowance was made for slip, as the pumps were single-acting and no leakage around the plunger was observed. The feedwater and coal used were carefully weighed. The moisture in the steam was measured by a Carpenter throttling calorimeter.

The diameters of the engine cylinders are 27 ins., 46 ins. and 70 ins. The pump plunger is 32.746 ins. diameter. The common stroke is 60 ins. The percentages of clearance in the various cylinders are: high-pressure, 1.36%; intermediate, 1.45%; low-pressure, 2.51%. The average percentages of moisture in the steam delivered to each engine were, respectively, 1.23%, 1.24% and 1.48%.

The following are the principal results of the test:

Temperature of feed.....	102°
Percentage of ash.....	8.4
Coal burned per sq. ft. of upper grate per hour (Hawley furnace), lbs.....	19.62
Water delivered in 24 hours by each engine: No. 1, 15,532,281 gallons; No. 2, 15,261,900 gallons; No. 3, 15,177,168 gallons.	
Water evaporated per lb. of coal, lbs.....	7.926
" " " " combustible, lbs.....	8.653
" " " " hr. per sq. ft. heat.	2.787
surf. lbs.....	
Equivalent evap. from and at 212° per lb. of coal.....	9.075
Equivalent evap. from and at 212° per lb. of combust.....	9.907
Duty:	
Ft.-lbs. per 1,000 lbs. feed-water.....	148,958,000
" " " " 1,000,000 B. T. U.....	134,643,030
" " " " 100 lbs. coal.....	118,022,900
" " " " combustible.....	128,832,500
Aggregate HP. delivered, all three engines, HP.....	1,031.47
Aggregate indicated HP., all three engines, HP.....	1,128.15
Mechanical efficiency of pumps and engines together.....	91.43%
Feed-water consumed per delivered HP. per hour, lbs.....	13.267
Feed-water consumed per indicated HP. per hour, lbs.....	12.13
Heating surface per indicated HP. per hour, sq. ft.....	4.35

It will be seen that the steam consumption per indicated horse power of this engine is one of the lowest records ever made; in fact, we do not now recall any which have equaled it. The com-



GENERAL ELECTRIC CO.'S TRIPLE EXPANSION VERTICAL ENGINE IN WORLD'S FAIR POWER PLANT.

Rated capacity, 1,200 HP.; cylinder diameters, 22½ ins., 33¾ ins., and 53¾ ins.; stroke, 36 ins.; speed, 100 revs. per minute (= 600 ft. per minute piston travel). Capacity of two 12-pole direct current dynamos mounted on ends of shaft, 7,500 16-c. p. lamps each. Total weight of engine, 160 tons; weight of dynamos, 8¾ tons. Surface condenser with independent air pump. All cylinders steam jacketed. J. C. Henderson, M. Am. Soc. M. E., designer.

is a new departure. We shall shortly illustrate and described it more fully. The Westinghouse exhibit is the largest engine exhibit in the Exposition, including six 1,000-HP. compound engines, each carrying a 15,000-light alternator on its shaft, and seven engines of smaller sizes, from 125 to 400 HP. As we have recently (Eng. News, Oct. 20, 1892) described the principal features of design in the Westinghouse compound engine, we need not refer further to it here.

The other type of vertical engine is practically a copy of the modern marine engine. The accompanying illustration shows a 1,200-HP. triple-expansion engine of this type, designed by Mr. J. C. Henderson, M. Am. Soc. M. E., and Chief Engineer of the General Electric Co. Another engine of similar general design, built by the Lake Erie Engineering Works, of Buffalo, N. Y., is working in the power station of the Intramural Railway. It has shown remarkable results in capacity, often running the entire road with 13 four-car trains unaided, and working at times under a load nearly

draws & Johnson Co., of Chicago, shows a high-speed two-cylinder single-acting engine designed especially for driving fans. It is very light, compact and perfectly balanced. The Duke Co., of Grand Haven, Mich., shows a rotating disk engine in small sizes; and the Rice & Whitacre Co., of Chicago, shows a small size very compact oscillating engine, which is built in sizes from 1 to 60 HP.

Two steam turbines are to be seen on the grounds, but only one of them is in operation. The De Laval turbine, the invention of Dr. Gustav de Laval, of Stockholm, Sweden, one of the inventors who has had much to do with the development of the centrifugal cream separator, is shown in Machinery Hall, running at a speed of 22,000 revs. per minute, and generating about 20 HP. The Dow turbine, which has been fully described in this journal, is not formally entered as an exhibit; but one can be seen on the Howell torpedo in the Hotchkiss, Ordnance Co.'s exhibit in the Transportation Building.

paratively low duty based on fuel consumption is due to the fact that the boiler efficiency was much below the engine efficiency, as shown by the evaporation records. The chief reason for the poor record made by the boilers was the fact that they were worked at too high a rate for the best results, only four being in use to supply the three engines.

On May 22 a test of the capacity of one of the engines was made. It was run for 2 hours 22 minutes at a piston speed of 190.7 ft. per hour, the normal being 162. At this higher speed its delivery was at the rate of 18,022,000 gallons per 24 hours, and the engine ran quietly and smoothly.

Both the duty and capacity tests were made by Mr. Jas. N. Warrington, of the R. W. Hunt & Co. testing bureau. The above summary of results is condensed from the formal report made by the testing bureau to Mr. S. C. Artingstall, City Engineer.

METHODS AND COST OF STREET CONSTRUCTION AT NEWTON, MASS.

The general subject of street construction, as practiced in Newton, is described in the report of Mr. A. F. Noyes, City Engineer, for the year 1891.

There were in the city at the time of the report about 114.2 miles of accepted and 55.4 miles of unaccepted streets, from 30 to 70 ft. wide. The city really consists of 13 villages having populations of from 500 to 5,000 each, the total population in 1890 having been about 24,000. Only a small percentage of the streets are of the country roads class.

Mr. Noyes describes the street construction system and related matters as follows, slight changes in form having been made:

The highways are under the supervision of a superintendent, who has three district foremen, who have the immediate supervision of the streets in from 3,000 to 5,000 acres of territory representing nearly equal mileage of streets.

Ledge or gravel lots of large area have been purchased in various sections of the city, so that the haul for material to any one section is rarely over a mile.

The ledges of the south section of the city are composed largely of conglomerate, in which the rounded or angular stones form a large percentage of the whole mass. The stones are of a granite character, and when broken make excellent roads. In the central portion of the city the ledges are largely a green variety of trap, resembling Hudson River trap in hardness, but not so desirable. In the north part of the city there are but few ledges, but the gravel banks are full of trap and granitic cobblestones of a superior quality.

Each district has two or three stables in which are kept from one to nine horses which are ready for immediate and constant use for any repairs which may be needed.

Wages paid per day of nine hours are as follows:

District foreman.....	\$3.50 to \$4.25
Engineer of road roller.....	3.00
Masons.....	3.50
Pavers.....	2.50
Ledgers.....	2.00 to 2.50
Drivers (double team).....	2.25
(single team).....	2.00
Subforemen and graders.....	2.00
Laborers.....	1.75

The charges made by the city on the highway books in determining the cost of any special work are:

For double team and driver.....	\$5.00 per day
For single team and driver.....	\$3.50 per day
For single load of broken stone of 26 to 28 cu. ft. at crusher.....	1.05
For double load of broken stone of from 40 to 42 cu. ft. at crusher.....	1.75

For rubble stone for foundation for telford road 50 cts. per cu. yd., except when obtained in the work.

At the above rates telford and macadam roads, 12 to 14 ins. deep, having from 8 to 9 ins. of rubblestone foundation placed; 4 to 6 ins. of broken stone and ½ in. to 1 in. surfacing material have been constructed for from 63 to 83 cts. per sq. yd. Macadam roads 6 to 8 ins. thick at 40 to 55 cts. per sq. yd. Macadam roads 4 to 6 ins. thick at 25 to 40 cts. per sq. yd.

The stone breaking plant consists of one stationary and one portable Farrel-Marsdon 9 × 15 stone breaker, operated, respectively, by one Atlas engine with horizontal boiler, and one portable Lidgerwood double cylinder engine with vertical boiler. The stationary plant is placed near a ledge of hard green trap stone. The stone is drilled with a Rand steam drill and blasted with forcite powder.

The drill is operated by steam from a separate boiler; the stone is broken to a size to go in the breaker by hand drilling or with sledge hammers, and taken by horse and cart to the breaker, a distance of

500 ft., and delivered on a platform, level with the top of the hopper.

It is fed into the hopper by two laborers. From the breaker the stone is delivered in four sizes into bins through revolving cylinders with casing of perforated boiler iron. The first is what is known as dust; second, 1 in.; third, 2½-in. stone; fourth, tailings that have passed by the meshes and out at the end of the cylinder.

The portable crusher is operated at the various gravel lots and some of the ledges at the south part of the city.

The stone is measured in the carts as drawn or shoveled from the bins. The units or weight of the stone of the different classes is obtained by weighing several cart loads which have been carefully measured, and found to be as follows, per cubic foot:

	Tailings, No. 3.	No. 2.	Dust.
Greenish trap rock.....	91.0	88.25	84.33
Conglomerate.....	94.4	87.70	101.00
Cobblestone.....	99.6	98.00	102.50

The following is a record in detail of the cost of the various items of labor and material which go to make up the total cost of breaking stone of the different classes:

	Hard, green trap rock resembling Hudson trap in hardness.	Conglomerate ledge stone.	Cobble stone, largely trap rock.	Cobble stone, largely granite.
Hours run.....	412	144	101	198
Cubic yards broken.....	3,155	1,288	1,173	1,785
Long tons, 2,240 lbs., broken.....	2,398	1,446	1,417	2,142
Short tons, 2,000 lbs., broken.....	3,805	1,620	1,587	2,339
Cubic yards broken per hour.....	7.7	8.9	11.8	9.0
Long tons ".....	8.2	10.0	14.0	10.8
Short tons ".....	9.0	11.2	15.7	12.1
No. cubic yards of tailings.....	1,004	378	205	365
Per cent.....	31.8	29.3	17.5	20.5
No. cubic yards 2½ in. stone.....	1,618	668	672	994
Per cent.....	51.3	51.9	57	55.1
No. cubic yards 1 in. ".....	323	.....	.....	.....
Per cent.....	10.2	.....	.....	.....
No. cubic yards ½ in. stone or dust.....	210	24	300	427
Per cent.....	6.7	18.8	25.5	23.4
Average No. of hours worked per day.....	9	9	9	9
Price Paid for Labor per Day and Material Used, Dollars.				
Foreman.....	3.00	3.00	3.00	3.00
Operator of stone drill.....	3.00	3.00	.....	.....
Ledgerman.....	1.75	1.75	.....	.....
Engineer of boiler operating stone drill.....	2.25	.....	3.60	.....
Engineer operating stone breaker.....	2.00	2.25	2.00	2.50
Blacksmith.....	2.50	2.25	.....	.....
Watchman.....	.....	1.75	1.75	1.75
Common laborer.....	1.75	1.50	1.50	1.75
Water boy.....	.....	1.00	1.25	.....
Two one-horse carts and one driver.....	5.00	5.40	.....	5.00
Coal per ton, 2,000 lbs.....	5.25	5.25	5.25	5.50
Oil per gallon.....	.65	.65	.65	.65
Powder per box 50 lbs.....	11.34	11.34	11.31	94c.
Waste per lb.....	94c.	94c.	94c.	.447
Cost per cubic yard stone in bin or crusher.....	.898	1.113	.445	.372
Cost per long ton.....	.834	.991	.37	.332
short ton.....	.745	.885	.33	.....
Cost, and per Cent. of Whole Cost, of Units of Labor and Material.				
Labor.....	Per cent. of cost.....	.092	.....	.....
steam.....	Per cent. of cost.....	10.3	.....	.....
drilling.....	Coal, oil, waste, powder and repairs.....	.084	.018	.....
Labor hand.....	Per cent. of cost.....	9.4	1.6	.....
drilling.....	Cost per cu. yd.....	.....	.249	.....
Sh'p'g drills and tools.....	Per cent. of cost.....	22.3	.....	.....
Br'k'g stone for crusher.....	Cost per cu. yd.....	.069	.023	.....
Total cost of preparing stone for crusher.....	Per cent. of cost.....	7.7	2.1	.....
Filling carts.....	Cost per cu. yd.....	.279	.42	.....
Carting to crusher.....	Per cent. of cost.....	31.0	37.8	.....
Feeding crusher.....	Cost per cu. yd.....	.525	.681	.....
Engineer of crusher.....	Per cent. of cost.....	.098	.127	.....
Coil, oil and waste.....	Cost per cu. yd.....	11.0	11.4	.....
Repairs.....	Per cent. of cost.....	.072	.062	.....
Moving and setting up portable crusher.....	Per cent. of cost.....	8.0	5.6	.....
Watchman.....	Cost per cu. yd.....	.053	.053	.....
	Per cent. of cost.....	5.9	4.7	.....
	Cost per cu. yd.....	.031	.038	.....
	Per cent. of cost.....	3.4	3.5	.....
	Cost per cu. yd.....	.079	.05	.....
	Per cent. of cost.....	8.8	4.5	.....
	Cost per cu. yd.....	.041	.....	.....
	Per cent. of cost.....	4.5	.....	.....
	Cost per cu. yd.....	.023	.....	.....
	Per cent. of cost.....	2.1	.....	.....
	Cost per cu. yd.....	4.4	5.4	6.6

ACCELERATED TESTS FOR THE PERMANENCY OF VOLUME OF CEMENT MORTAR.

By Fred. P. Spalding, M. Am. Soc. C. E.

Tensile tests of cement extending over short periods of time give but little indication of the

real value of the material. While they are useful as showing that the cement will set and harden properly, they do not give an indication of the more important quality of endurance. In fact, with some cements, the possession of a high degree of early strength is to be regarded as suspicious, and may be due to a composition which will eventually cause its disintegration. It is well known that the ordinary method of testing durability, or permanence of volume, by leaving a pat of neat cement in air or water of normal temperature for a few days, is quite inefficient, and hence many tests, intended to give a more accurate indication, have been proposed, most of them depending upon the advancement of disintegration by the action of heat upon the cement.

For the purpose of obtaining a comparison of several of these proposed tests with each other, and of determining whether the results shown by them are real indications of the value of the material tested, the writer, in connection with the work of instruction in the cement laboratory of the College of Civil Engineering, Cornell University, has subjected a number of samples of cement to each of the tests, and has also observed the action of the same samples under the ordinary cold tests extended over considerable periods of time. The samples of cement used in these tests are all of well known brands, in common use in this country, and were taken for this purpose because they were conveniently at hand, and seemed to represent all grades.

Table I. gives a list of the cements upon which experiments were made, with their general characteristics, together with the results of tensile tests of neat cement. The briquettes for these tests were all mixed and molded by hand, and kept for 24 hours in air before being immersed. Tests were also made, in some instances, of briquettes kept in hot water, and the results of these are given for comparison with those kept cold. The tests for permanence of volume, to which these samples were subjected, were as follows:

(1) Cold Water Test.—Pats of neat cement, about 3 ins. in diameter and ½ in. thick, were made on a glass surface, kept in moist air for 24 hours, then immersed in cold water (55°-60° F.), and observed at intervals for periods reaching to six months and one year. The results of these observations, together with the corresponding tensile strengths, are thought to give a fair indication of the actual durability of the material. The pats for this and the other tests in which they were used were ordinarily made by the method of Professor Titmayer, of Zurich, by rolling a ball of the cement in a dry plastic condition, and then flattening it to the required form. The water used was slightly more than for briquettes, and was determined by the method; if too wet, the material will not hold the form of a ball; if too dry, the ball will crack in flattening.

(2) Cold Air Test.—The pats, made as above, were kept in the air in the laboratory for various periods, and examined as in the first case. There was no indication of a failure on the part of any of the samples under this test, and it is not included in the table. All of the pats were sound and hard after six months.

(3) Boiling Test.—In this test the pats were placed immediately after mixing in cold water, and the temperature of the water then raised gradually (in about an hour) to ebullition, which was continued for three hours, after which the pats were examined for checking. In all of the tests by this method the results were very pronounced. The pat at the conclusion of the test was either perfectly sound and hard, or it was checked and softened to disintegration.

(4) Steam and Hot Water Test.—This test was made in two ways. By the first, the pats immediately after mixing were placed in steam at about 175° F. for two hours, and then transferred to water about 200° F. for 22 hours, after which they were examined as in the other tests for checking and softening. By the second method the pats were kept in air for 24 hours before placing them in the steam, otherwise the conduct of the test was the same as before.

(5) Flame Test.—For this test balls of neat cement about 1½ ins. in diameter were placed, immediately after mixing, in the flame of a Bunsen burner, and gradually heated, until in about three-quarters of an hour they were made red hot, and

kept so for about fifteen minutes, after which they were examined for cracks. The results of this treatment upon the balls were of three kinds; some became very hard and firm, some showed slight surface cracks although the balls were quite hard, and some cracked and scaled off on the surface with the interior soft and simply dried out. These results are differently noted in the table.

(6) Kiln Test.—The pats, after being kept 24 hours in moist air of normal temperature, were placed in a drying oven, and maintained at a temperature of 250° F. for three hours, after which they were examined. No results of any value, so far as detecting unsoundness is concerned, were obtained for this test, and only the last 11 cements of the table were subjected to this treatment. All of the pats retained their form and no cracks appeared, although some were not very hard and could be easily crushed. These results are therefore omitted from the table. Repetitions of the kiln test were made, using a temperature of 300° F., and also by placing a shallow dish of water in the oven to keep the air moistened with steam. These gave practically the same results as before, but when the water was used, all of the pats were very hard and firm.

(7) Chloride of Calcium Test.—In this test, the pats were mixed with a solution of 40 grammes of chloride of calcium to a litre of water. After mixing, the briquettes were kept in the air until firmly set, then placed in the same solution as was used in mixing, and examined after 24 hours for checking and softening. The results of the above tests are given in Table II. In giving the results in the table the word checked is used to indicate that the process of disintegration had begun for the cement, although in some cases it was advanced to completion. An inspection of the table will show that of the 21 samples tested, six proved to be unsound when exposed for a considerable time to the cold water test. Two of these might have been detected by the ordinary short time cold test, as they began disintegration very soon, the other four would have been accepted on the ordinary test for soundness. By the boiling test seven cements fail, of which six are the same samples which fail upon the cold test. The seventh shows no sign of failure after eight months in the cold water. Pats of this

have rejected only such cements as will eventually disintegrate in cold water, although the interpretation of the results of the dry flame test is somewhat doubtful. The degree of the tendency to disintegrate is graded by the severity of the test. Steaming the pat before putting it in hot water augments to some extent its resistance to disintegration. Allowing it to firmly set before subjecting it to the test still further increases its power of resistance.

A test sometimes proposed for cements, is that of the rise of temperature in setting as indicating the presence of free lime. The test does not seem to have been introduced in specifications, but is frequently made in laboratories. The writer has

distinguishable in their action from the sound slow-setting cements, while samples K, Q and S show a rise of from 6° to 10° F. during setting.

In the tables are also given comparisons of the other than is given by a statement of the results obtained in these few experiments. The principles involved in them have been recently quite fully discussed, so far as our present knowledge admits. The question really in issue in the adaptation of these tests to practice is whether, or to what extent, the tendency toward disintegration shown by a cement in the form of a small pat, should bar its use in construction. That it indicates a possible danger, and should be at least seriously considered is evident.

TABLE II.—Tests of Cement for Permanency of Volume.

Design of sample.	Pats of neat cement subjected to test. Steam and hot water test.						Tensile strengths of cement mortar, lbs. per sq. in. (cement, 1; sand, 3.)			
	Cold water test, 55°, 60° F.	Boiling test.	Immediately after mixing.	After 24 hours.	Flame test.	Chloride of calcium test.	In hot water.		In cold water.	
							3 days old.	7 days old.	7 days old.	28 days old.
A	Sound after 1 year	Sound	Sound	Sound	Sound	Sound	45	65	58	117
B	"	"	"	"	"	"	60	125	66	142
C	"	"	"	"	"	"	51	85	80	122
D	"	"	"	"	"	"	72	120	117	163
E	"	"	"	"	"	"	129	150	155	212
F	"	"	"	"	Slightly cracked	"	75	122	100	174
G	Checked in 3 mos.	Checked	Checked	Checked	Cracked and soft	Checked	30	50	50	104
H	Sound after 1 year	Sound	Sound	Sound	Surface cracked	Sound	55	117	70	125
I	Checked in 6 mos.	Checked	Checked	Sound	"	Checked	165	190	95	170
J	Sound after 1 year	Sound	Sound	"	Sound	Sound	57	96	80	141
K	" 6 mos.	"	"	"	"	"	76	128	106	188
L	"	"	"	"	"	"	137	160	134	161
M	"	"	"	"	"	"	70	113	101	159
N	Checked in 9 mos.	Checked	"	"	Cracked and soft	Checked	128	132	100	161
O	"	"	Checked	"	Surface cracked	"	45	57	32	48
P	Sound after 6 mos.	"	Sound	"	"	Sound	27	68	52	92
Q	"	Sound	"	"	Sound	"	"	"	"	"
R	Checked in 1 week	Checked	Checked	Checked	Cracked and soft	Checked	40	55	57	102
S	Sound after 6 mos.	Sound	Sound	Sound	Sound	Sound	"	"	"	"
T	Checked in 2 days	Checked	Checked	Checked	Cracked and soft	Checked	"	"	"	"
U	Sound after 6 mos.	Sound	Sound	Sound	Sound	Sound	75	90	48	80

not seen the results of any direct experiments showing in what manner this action relates to unsoundness in a cement, but in his own work has found that the change in temperature seemed to vary with the rapidity of action, a quick-setting cement showing considerable rise, a slow-setting one little or none, and in neither case apparently having any relation to the soundness of the material. For example, cements I, N and T give a change scarcely appreciable and are not

The advisability of air slaking a cement before submitting it to tests is a question upon which there is some difference of opinion among users of cement. It is frequently observed that when cement which has been shipped in barrels is opened and tested at once that it gives very poor results, but if it be exposed to the air for a few days, the results are much improved. This is especially apt to be the case with quick setting cements, which at first will set much too rapidly, and harden afterward too slowly, giving a very low tensile strength. They may even show a slight disposition to blow, but in a few days' exposure they regain the normal condition with regard to all of these points. When the cement is to be used directly from the barrels as opened, the advisability of giving it the benefit of air slaking will depend upon its ability to eventually harden to the same strength when mixed at once, as it would if mixed after being aired.

With relation to two cements, J and K, of Tables I. and II., showing this tendency, this has been observed, with the following result:

Sample.	Tensile strengths after			
	1 week.	4 weeks.	13 weeks.	26 weeks.
J—before air slaking				
—set in 6 min.	90	243	560	
J—after air slaking—				
—set in 24 min.	315	528	580	
K—before air slaking				
—set in 8 min.	136	285	480	565
K—after air slaking				
—set in 20 min.	442	502	535	551

In these cases the hardening seems to have been slow at first, but finally to have reached full strength. It is not known to the writer whether these are unusual results, as he has not seen any similar tests made by others, but has noticed in other cases what appeared to be similar occurrences.

Keeping a cement for a considerable time in dry air will not in general injure it, if it be a good cement, but a poor one is apt to deteriorate when so kept; for example, portions of samples B, C, D, E and H after remaining in the laboratory for more than a year, were re-tested with practically the same results as at first; A and J gave somewhat higher results upon re-testing, while I and N, after one year, and nine months, respectively, showed practically no strength. As these two latter were shown unsound by the tests, it seems probable that their deterioration may be due to defective composition. With some other bad cements, however, this is not the case, but the writer has seen no case of a good cement being injured by keeping, unless in contact with moisture which caused it to set before using.

TABLE I.—Showing Physical Characters and Strengths of the Cements Tested for Permanency of Volume

Design of sample.	Kind of cement.	Fineness.			Time of setting by Vicat needle minutes.	Tensile strengths, lbs. per sq. in.											
		Per cent. passing sieves.				Kept in water at 60°						Kept in water at 200°					
		2,500 mesh.	6,400 mesh.	32,400 mesh.		2 days old.	1 week old.	4 weeks old.	13 weeks old.	26 weeks old.	52 weeks old.	2 days old.	1 week old.	4 weeks old.	13 weeks old.		
		91	77	62		25	221	312	490	620	675	720	242	390	451	470	
A	English Portland.	91	77	62	25	221	312	490	620	675	720	242	390	451	470		
B	"	93	82	67	90	234	397	491	627	720	720	214	246	366	420		
C	German	98	88	67	240	322	491	627	720	720	720	214	246	366	420		
D	"	99	93	70	300	307	487	580	672	720	720	214	246	366	420		
E	American	96	86	66	185	315	487	523	720	720	720	214	246	366	420		
F	"	100	91	68	95	307	454	501	702	702	702	214	246	366	420		
G	"	99	94	34	320	202	249	282	490	691	691	214	246	366	420		
H	"	98	94	76	300	125	240	426	490	691	691	214	246	366	420		
I	"	99	95	71	465	406	792	865	825	825	825	214	246	366	420		
J	English	95	88	62	24	315	528	580	740	740	740	242	390	451	470		
K	"	95	84	58	20	260	442	502	535	551	551	242	390	451	470		
L	German	98	94	65	321	213	371	487	541	560	560	242	390	451	470		
M	American	99	96	70	90	221	352	429	521	556	556	214	246	366	420		
N	Belgian	97	92	68	400	186	342	495	545	567	567	275	410	415	415		
O	American natural.	97	92	84	250	43	76	96	140	165	165	74	94	101	109		
P	"	95	90	83	240	60	118	175	265	265	265	113	190	260	315		
Q	"	98	92	75	105	136	166	196	292	302	302	87	153	283	242		
R	"	97	90	80	220	135	145	178	275	275	275	135	160	205	205		
S	"	99	91	78	30	125	145	178	275	275	275	135	160	205	205		
T	"	95	90	77	310	69	148	180	180	180	180	61	70	70	70		
U	"	97	89	72	40	95	125	165	220	275	275	135	150	152	152		

sample are still in the cold water, and observation of them will be continued.

By the steam and hot water test, the first method rejects five of the six unsound cements, the sixth being that which requires longest to check when cold, while the second method only points out three, and fails to indicate one that began to disintegrate in four months when cold. It was found that by both of these methods, this test could be made to show as defective all of the samples rejected by the boiling test, by continuing the test longer, while several of the other samples were subjected to the hot water for two weeks without exhibiting any signs of checking. The flame test shows as cracked and softened four of the six suspected samples, while two are only slightly cracked, just as are four of those shown as sound upon the other tests. The chloride of calcium test condemns the same six cements that have disintegrated in the cold water.

For the 21 cements upon which experiments were made, it seems certain that the accelerated tests

strengths of briquettes of cement kept in hot with those kept in cold water; in Table I. of neat cement, extending over a period of three months, and in Table II. of 3 to 1 mortar as sometimes used in tests for permanence of volume. These results indicate the already well known fact, that no direct ratio exists between the strengths hot and cold, and also seems to indicate, contrary to the usually accepted theory, that there is no necessary connection between the soundness of the cement and the strength it may develop in hot water. It is known that the addition of caustic lime to a Portland cement will both render it unsound and cause it to show less strength in hot than in cold water, and this test for permanence of volume, by the comparison of hot and cold strengths, is dependent upon the hypothesis that any free lime which may exist in the cement will produce the same result, and that the unsoundness of the cement is necessarily caused by free lime.

It is not proposed at this time to enter into any discussion of the merits of the accelerated tests,

THE TOPOGRAPHICAL WORK OF THE U. S. GEOLOGICAL SURVEY.

The following concise and excellent description of the fieldwork methods of the U. S. Geological Survey was written by Mr. G. F. Sherman, an undergraduate of Columbia College School of Mines, after a stay of a week with a party in the field. We slightly condense it from the pages of the "School of Mines Quarterly":

The U. S. Geological Survey was originally organized for the purpose of exploring and locating the geological areas of the United States. Almost as soon as the work was commenced it was found that a reliable map, on which to show the geology, was imperatively necessary. At present, the survey is occupied in making a series of contour maps on which the geological areas are to be subsequently indicated.

The map-making work of the geological survey may be divided into two parts—the office and field-work. The office work consists in inking in the maps on which the fieldwork is finished, and preparing them for the engraver; and in plotting the initial points on the plane table sheets to be used later. These initial points are located by triangulation, either by the Geological Survey itself or by the U. S. Coast and Geodetic Survey. They also use data occasionally furnished by other reliable surveys; for instance, the triangulations conducted by the New York State Survey and the U. S. Lake Survey. In the East, the Geological Survey has to do very little triangulation of its own, as the Coast Survey has pushed its triangulation in some cases far into the interior, even across Vermont and New Hampshire and north of Albany. The fieldwork done by the topographers of the survey consists in locating the roads, streams, and inhabited houses, generally by means of the plane table, and in sketching the contours on the skeleton sheets thus obtained. The fieldwork for details is done as follows:

On taking the field in the spring, the parties usually consist of three men, the topographer in charge, the plane-table man, and the traverse man; though sometimes the parties are cut down to two, who divide the work somewhat differently. The plane-table work will first be taken up, next the road traversing, and finally the sketching, as nearly as possible in the order of progress.

The Plane-Table Work.—The outfit used is particularly light and convenient, while sufficiently strong and steady for all ordinary work. The tripod has a quick-leveling attachment, consisting of a ball-and-socket joint, which may be clamped in any position, but has neither leveling nor tangent screws. The paper is very stiff, and is made of two thicknesses mounted together, with the grain in different directions to prevent expansion and contraction in damp or dry weather as much as possible. The sheet is nearly as large as the table, and is screwed to it, not being removed or changed until it is finished. The sheets cover an area of 15' of latitude by 15' of longitude, and the 5' lines of latitude and longitude are drawn in on a scale of 1:45000. These lines and the primary triangulation points are plotted and inked in at the office before taking the field. There are no especial features in the rest of the apparatus.

The object of the plane-table work is to locate a sufficient number of points to enable the traverse man accurately to tie in his road traverses. The methods used in determining these points are those used in all plane-table surveys, the three-point problem, from its convenience, being often employed. It requires a little experience to decide which are points worthy of location, and, having decided, to fix them in the mind so that they may be recognized and located from another station. Besides this, they must be described so that the traverse man may identify them with locations of his own. Their system of notes simplifies this to a certain extent. (We omit some of the details on this head.—Ed.)

Having obtained a satisfactory location, the remaining work of the station may be divided into three parts—the locating of stations to which lines have been drawn from other stations, the shots to new stations or intersection-points, and the vertical angle work. In all these divisions, the same order of work is followed. The stations to the south, for instance, are observed first, then those farther west, passing around in this manner to the north and east, until all have been sighted. This method prevents to a great extent confusing and omitting points.

In the first part of the work the shots are numbered, the numbers having been carried on continuously from the beginning of the sheet. These numbers are placed in a column headed "No." Then the notes are examined until the number of the other shot to the same point is found and entered on the same line in a column headed "Equals." This first line may be called the direction line, and the second the locating line. The number of the locating line is then entered in the "Equals" column, on the line with the number of the direction line. This system shows that the point

is located, giving the numbers of both lines in both places where any mention of the object is made.

In the second part direction lines are taken to new points. The number of the line is entered as before in the "No." column; the "Equals" column is, of course, left blank for the number of the locating shot, and a short description of the point is given on the opposite page.

The vertical angle work consists in reading the angles to most of the points, and to almost all of the stations that can be seen. Reading to different stations gives a system of checking elevations by making them interdependent one on another. It is a method of reciprocal adjustment. The vertical angles are read generally to the ground at the location. When this is not the case an explanatory note is entered with the description on the opposite page. When convenient, usually at night or on rainy days, the distances between the points and locating station are read off on a scale, and the vertical heights corresponding to the distances and their respective vertical angles are taken from a table in which allowance is made for the curvature of the earth, refraction, etc. The results are the differences in elevation between the station and unobserved points. They find that in the vertical angle work very long shots are not desirable; that there is a limit beyond which the work does not check very well. This limit is about eight or ten miles for the scale under consideration. Otherwise the vertical angles check remarkably well, usually within 10 ft.; in fact, rarely exceeding that limit.

The plane-table work is very good, intersections and resections checking almost exactly. Every possible advantage is taken of circumstances. The shots to the important stations are taken in the morning and evening when possible; to the western stations in the morning and to the eastern in the evening, when the sun will be shining directly on the object and not into the telescope.

Road Traversing.—The instruments used in road traversing are the traverse table with its alidade, and a buggy wheel, which is used in measuring distances.

The traverse table consists of a board about 18 ins. by 18 ins., mounted upon a light tripod similar to that of the large table. The board has set into it a declinator, and the table is always oriented by its means unless there is evidence of a large amount of local attraction. This necessitates the paper being fixed in position. The alidade is merely a metal straight-edge to which a pair of compass-sights have been attached, with the line of sight parallel to the fiducial edge.

The buggy wheel is measured, usually by stretching a tape around its circumference, and its revolutions are counted by the traverse man. This method is found to be as accurate and much more convenient than any odometer or cyclometer in use. To assist the counting, a rag is tied to one of the spokes. The scale used, 1:45,000, is divided into 100 parts, a mile being taken as the unit. The number of wheel revolutions to the smallest scale division is calculated, and a small table is made to convert wheel revolution to scale divisions. This may be tacked to the traverse table for convenience in using.

Any convenient point is taken as a starting point, and its position is assumed upon the traverse sheet. Setting up at this starting point, the table is oriented with the compass, after being leveled by the eye, as there are no level-bubbles. Shots are taken down the road or roads in both or all directions. Then, getting in the buggy, the wheel is counted to the next turn or bend in the road. The number is noted and a new count commenced, which continues until the second bend is reached. Then the table is set up and oriented as before. We have plotted the first line of the road from the first station. Laying off the distance to the first bend, we locate that point. But the road is straight between that point and the point at which the table is now set up. So, resection on the line of road between them, we lay off the second distance and obtain the position of the table. By repeating this operation a road may be run for any distance. After all the roads in the vicinity are traversed, they form a network which checks and ties itself together.

While the road traversing is going on, many points are located off the road—by intersections, in the more accurate locations, or by offsets; for instance, to houses close to the road. In this way streams crossing the road and all inhabited houses are located, together with all important objects which may, by any chance, have been located by the large plane table. Locations off the road which may assist the topographer are also taken. These are usually the tops of hills or points lying on the edge of a bluff, etc. In some cases, when a piece of important topography lies at a distance from any road, the traverse man may go so far as to run a line of triangulation over to it, but this is rarely necessary.

In the evenings the traverses are "adjusted" with the assistance of the points located by the plane table, and the road skeleton is transferred to

another sheet. There are four of these sheets to go with each plane-table sheet, each $7\frac{1}{4}'$ lat. by $7\frac{1}{4}'$ long. (one-quarter of the large sheet), plotted to the same scale. To the proper one of these quarter sheets are transferred, with the assistance of tracing paper, all the points located in that quarter of the plane-table sheet. Then a small portion of the road traverse, with the locations which the plane table and traverse sheets have in common, is traced very carefully and laid over the quarter sheet, applying common points to each other. This tracing may not fit exactly, but it is adjusted to the best advantage, and the points are pricked through. All the matter of the traverse sheet is thus transferred to the quarter sheet, and it is then inked to prevent erasure or smearing in the process of stretching. This material furnishes the "instrumental control" on which the contours are sketched.

Although this method seems very rough, it is surprisingly accurate—practically as accurate as the transit and chain traverse, which it has superseded. It has the decided advantages over the transit traverse of being much more rapid and making possible the location of any number of points off the road. If any mistake is made, the adjustment of the traverse shows immediately where it is, so that it may often be corrected without going into the field. With the transit there are many calculations to be made before the traverse can be plotted and used by the topographer, while if there is a blunder it will perhaps not be discovered until plotting, which may not occur until the following winter. Locating points off the line, too, will take so much time that few can be afforded.

The Sketching of Contours.—The topographer sketches on these quarter sheets contours at a vertical interval of 20 ft., having the assistance of an aneroid barometer and knowing the elevations of a number of plane-table locations. The sheet is usually tacked to a small board.

He starts at any point on a road and makes as small a circuit as he can, following roads; sketching, as he goes, the contours that cross the road; and taking his elevations from an aneroid which he has set to read correctly at a point of known elevation. He sketches these contours in, as far as he can follow them, on each side from the road, using the points located by the road traverses and plane-table to check his bearings, distances and elevations. Usually, by the time he has completed his circuit he is able to join the ends of the contours drawn from different sides, and finish the portion inclosed without leaving the road. In cases where the inclosed area is very large and there is a space which cannot be seen from any point of the road, he is obliged to walk over and sketch in the omitted part, pacing distances and checking positions, as before, on the located points. The work is greatly strengthened by sketching in a circuit, as it enables one to observe the contours from several different points and modify one's ideas to fit the real shape of the ground. Joining the contours sketched from different roads is also a good check, and helps the work done for both roads. The sketching is greatly assisted by numerous locations off the road in the proper places, and the traverse man would do better to have too many auxiliary points than too few.

The aim of the contours is to give a correct idea of the form of the country, and in order to do so the topographer occasionally exaggerates slightly. For instance, if a flat-topped hill has a knob at one end that does not quite reach a certain contour, a contour may be drawn around the top to show that there is a knob, and which end of the hill is higher.

The aneroid is set at the beginning of the day, and is compared as often as possible with known elevations. On some days it stands very steadily and does not have to be changed, while on others it has to be continually watched and reset as check-points are reached and circuits closed.

Besides sketching the contours and drainage, the topographer dots in the woodlands to furnish data for an estimate of the timber lands of the United States.

The sketching is by far the most difficult part, and to sketch well a great deal of experience is necessary. The object of the work is seen at a glance. Practice, and in most cases a great deal of practice, is the only means which will enable one to arrive at the desired result.

This finishes the fieldwork.

In the winter the quarter sheets are fully inked in, and photographed down to a scale of 1:62,500 on very thin paper. These photographs are then transferred to the final sheet by blackening the back of the paper and tracing over the lines with a sharp ivory point. The final sheet is then very carefully inked in and lettered. The fieldwork should be carried beyond the boundaries of the quarter sheets a little to assist in joining them together. The finished whole sheet is next engraved upon three copper plates; one for the black, for "culture" and lettering; a blue plate for water; and a brown one for the contours. From these plates lithographic stones are prepared, and a few

proofs printed, which are sent for correction to the topographer who made the survey. When the proofs are approved, the sheet is printed.

PENNY-IN-THE-SLOT GAS METERS IN LIVERPOOL.

Automatic gas meters which are put in operation by dropping a penny (2 cts.) in the slot are in use in Liverpool, England, and the Liverpool "Mercury" says that the device has come into very popular favor. In 1890 over 100 meters were at work in Liverpool, and from that time until now the difficulty is said to have been to construct the machines quickly enough to supply the enormous demand which now exists. In 1891 the company fixed 1,975 meters, in 1892 it fixed 4,038, and now in Liverpool alone there are between 8,000 and 9,000 automatic meters in the houses of those who hitherto have had to depend upon candles or oil for the illumination of their homes. Like every other invention, the automatic gas meter has since its initiation been subjected to various improvements. In its latest form there are in view of the householder three dials marked: "L," "S" and "D," and as soon as a penny is dropped into the slot the hand of the "D" dial records it. When twelve pennies have been dropped in, the "D" dial stands at "0," while the hand of the "S" dial records that one shilling's worth of pennies are in the drawer, and so on, until £20 (\$100) worth of gas is paid for. The hands can only move one way, so that by this invention the householder practically gets an indisputable receipt for the pennies he puts into the slot and the total amount he has paid for his gas. An indicator shows how many feet of gas are in the meter "paid for, but unconsumed." When all the gas paid for has been used the flame does not at once go out; but under a new arrangement the meter automatically warns the householder that the supply is nearly exhausted by gradually lowering the flame at least one hour before turning the gas off. It is to be hoped that the dials record more accurately than those of the ordinary gas meters are popularly supposed to record the quantity of gas.

PERSONALS.

Mr. A. W. Cooke has been appointed Chief Engineer of the Chicago Street Department.

Mr. J. T. King has been appointed Chief Engineer of the Alton Electric St. Ry. Co., of Alton, Ill.

Mr. Richard Bond, one of the pioneer railway builders of Canada, died at Toronto, Aug. 15, at the age of 82.

Mr. F. P. Read has been appointed Chief Engineer of the St. Louis, Chicago & St. Paul R. R., in place of E. M. Rice, resigned.

Mr. J. W. Schaub, M. Am. Soc. C. E., was married on Aug. 9, to Miss Harriett Holmes, of Milesburg, Pa. Mr. Schaub is now located at Pottsville, Pa.

Mr. George Howard Ellers has been appointed to a position defined as follows: "Consulting Engineer to his Honor Mayor Harrison (of Chicago), in special charge of the abolition of grade crossings."

Mr. C. G. Waldo, who has been assistant to President M. D. Woodford, of the Cincinnati, Hamilton & Dayton system, has been appointed General Superintendent in place of Mr. Charles Neilson, resigned.

Mr. William A. Nettleton has been appointed Assistant Superintendent of Motive Power and Machinery, of the Kansas City, Fort Scott & Memphis system. He is a son of George H. Nettleton, President and General Manager of the system.

Mr. W. Chauncey Hawley, M. Am. Soc. C. E., has been engaged as First Assistant Engineer to Professor Raymond, on the new water supply system of Troy, N. Y., with headquarters in that city. Mr. Hawley was until recently with Mr. Chester B. Davis, of Chicago.

Mr. Albert F. Noyes, M. Am. Soc. C. E., submitted his resignation as City Engineer of Newton, Mass., noted in our issue of Aug. 3, to accept the position of Chief Assistant Engineer of the Massachusetts State Board of Health. Mr. Noyes will be engaged on the investigation for a metropolitan water supply for Boston and its suburbs, mentioned in our issue of June 29, 1893.

M. de Travenier, Chief Engineer, Ponts et Chaussées, and engineer in charge of the departments of Public Parks, Electricity, etc., for the City of Paris, is in the United States especially commissioned to report upon the World's Columbian Exposition for that city and to examine the chief engineering works of this country.

M. de Travenier was formerly chief engineer of all the Paris streets, and in this capacity has visited all the important asphalt and bitumens in Europe. He is also the designer of a project for a metropolitan railway for Paris, and also a railway for the proposed Paris exposition of 1900.

Mr. Lucius Tuttle was elected President of the Boston & Maine R. R. Co. at the directors' meeting on Aug. 22. Mr. Tuttle's rise to prominence in railway circles has been rapid. He began railway service in Hartford in 1865 as a ticket clerk, and in 1878 he became General Passenger Agent of the New York & New England R. R., and has since that time been in charge of the passenger departments of the Eastern, Boston & Lowell, and Canadian Pacific. During 1889 he was in charge of the passenger department of the Trunk Line Traffic Association, which post he left to become General Manager of the New York, New Haven & Hartford system. He was elected Vice-President of that company in February, 1892.

NEW PUBLICATIONS.

REPORT OF THE CHIEF OF THE DIVISION OF FORESTRY FOR 1892. By B. E. Fernow. Pub. Doc. Pamph., pp. 65, with six plates.

This report contains an interesting monograph on the naval stores industry as carried on in the United States and foreign countries, with suggestions for the improvement of the former.

THE TWIN CITIES OF THE BORDER, and the Country of the Lower Rio Grande. By Lieut. W. H. Chatfield, U. S. A. Brownsville, Tex. Quarto, paper, pp. 48, with illustrations and map.

This is an interesting and well prepared pamphlet setting forth the advantages of the extreme southern portion of Texas as a place of business and residence. Copies can be obtained by addressing the author as above.

SOCIETY PROCEEDINGS.

INTERNATIONAL MARITIME CONGRESS.—At the Paris Exposition of 1889 an International Maritime Congress was held and an organization was effected looking to further meetings. In accordance therewith invitations were extended for a second meeting, which was held in London July 18 to 21. The Congress met in four sections, as follows: Sec. I. Harbors, breakwaters, etc. Sec. II. Docks and dock equipment. Sec. III. Shipbuilding and marine engineering. Sec. IV. Lighthouses, fog signals, etc. The number of papers presented and discussed before these various divisions numbered over 40. Those of most interest to our readers we shall abstract later, in connection with similar papers before the International Water Commerce Congresses held at Chicago. The Congress was well attended by engineers from the Continent as well as by English engineers, the visitors from France being especially numerous.

THE INSTITUTION OF MECHANICAL ENGINEERS.—(From Our London Correspondent.)—The summer meeting was held Aug. 1 to 4, at Middlesbrough. England's newest manufacturing town, the center of the great Cleveland iron district. Since steel has so largely superseded iron, Cleveland ore has given place to a great extent to the hematite ore imported from Bilbao, Spain. The basic process of steel-making, which would enable the native phosphoric ores to be used, has not been made a commercial success in the Middlesbrough district. The advantages of Middlesbrough as a port for the reception of Spanish ore, no doubt, accounts for the fact.

The first paper read was by Mr. Jeremiah Head, entitled "Recent Developments in the Cleveland Iron and Steel Industry." A point of interest, perhaps, to American readers, although the question has been rather fully debated before, was a comparison between the celebrated Edgar Thomson furnaces and some of those at Middlesbrough. It appeared to be the opinion of the majority of English blast-furnace managers present that the slower working common in English practice was better suited to local circumstances.

One gentleman in the discussion estimated that the longer life of the English furnace as compared to some of those of America enabled a larger quantity of materials to pass through, so that in terms of the materials used the English furnaces showed a higher average; it, of course, being understood that with less pressure of blast a furnace lasts longer. In one case quoted, a furnace had been at work for 17 years.

Mr. Richard Grigg described the Middlesbrough salt district. This is an industry which has sprung up recently, but is already assuming large proportions. The salt occurs at depths of 1,000 to 1,700 ft. At first tube wells were sunk by the diamond drill, but this process was too costly, so the American method of well-sinking, as followed in the oil districts, was adopted. The great problem which is agitating Middlesbrough now is whether the extensive pumping of brine will lead to subsidence, as in the Cheshire salt district, where land settles over the brine springs in a most remarkable and unpleasant manner. Middles-

brough salt is far deeper—that is one element of safety; but should the overlying stratum of rock give way it may snap as suddenly as a girder and the results would be disastrous. In the meantime the salt-makers go on pumping, for there is no legal process by which they can be stopped, and the blast-furnace managers are beginning to tremble for the safety of their works.

A paper by A. L. Stevenson described the application of electricity to drilling in the Cleveland iron mines. It will surprise American engineers to learn that all the drills in use here are of the rotating type. In fact, they bore the hole instead of drilling it. These rotary drills have been operated by compressed air, hydraulic power, oil engines and electricity, and the last method is superseding all the others. The last paper was by Mr. G. J. Clarke, Engineer to the Tees Conservancy. In this he described briefly how the little creek which nature made the Tees has been transformed into a navigable river, up which ships of the largest size can sail to the docks at Middlesbrough. Well within the memory of those not much above middle age the Tees was fordable not far from its mouth. In 1863 there were 3½ ft. at low-water on the bar; now the minimum depth is 27 ft.; while there is 37 ft. at high water.

This improvement has been effected by the construction of training walls, by dredging, and by the erection of breakwaters. The South Gare breakwater, which protects the entrance to the river, took 24 years to build; it is constructed of Portland cement concrete, laid down upon a foundation of slag, and has a slag hearing. In this way a vast quantity of useless material which was a source of expense to the iron manufacturer, occupying valuable land for dumping ground, has been put to a useful purpose. The breakwater is upward of 2¼ miles in length. The opposite breakwater—that of the North Gare—has been completed for a length of 3,330 ft. This is of solid Portland cement concrete, backed by slag balls, for an average width of 50 ft. These slag balls weigh about 3½ tons each, and are brought in special barges, which carry 40 slag trucks, each containing one ball. About 1,000,000 tons of slag have so far been used in the construction of this breakwater, and 5,000,000 tons on the South breakwater. The head of the South breakwater has been protected by a wave-breaker of concrete blocks varying in size from 40 to 300 tons each. Blocks of 60 to 70 tons were built on launching ways, and launched by screw or hydraulic jacks.

COMING TECHNICAL MEETINGS.

- ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Sept. 1. Secy., E. K. Smoot, 908 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 1. Secy., O. Von Geldern, 719 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Sept. 2. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
At 180 La Salle St., Chicago.
Secy., John Ericson.
ENGINEERS' SOCIETY OF PHOENIXVILLE.
Sept. 5. Secy., W. Halliburton.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 6. Secy., F. Collingwood, 127 East 25d St., New York.
WESTERN SOCIETY OF ENGINEERS.
Sept. 6. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 6. Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF MINNEAPOLIS.
Sept. 7. Secy., E. Nexsen, 504 Kasota Block.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Sept. 9. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
Sept. 11. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Sept. 11. Secy., M. F. Schinke, City Hall.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Sept. 12. Secy., F. C. Osborn, Case Library Bldg.
ROAD MASTERS' ASSOCIATION OF AMERICA.
Sept. 12, 13 and 14. Annual Convention at Chicago, Ill. Secy., W. W. Sharpe, Waycross, Ga.
NORTHWEST RAILROAD CLUB.
Sept. 12. Secy., W. D. Crosmann, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Sept. 12. Secy., D. W. McMoris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
Sept. 12. Secy., F. E. King, Jacobson Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Sept. 13. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Sept. 13. Secy., F. M. Curtis, O. C. R. E., Boston.
ENGINEERING ASSOCIATION OF THE SOUTH.
Sept. 14. Secy., W. G. Kirkpatrick, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 14. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Sept. 15. Secy., D. W. Meeker, St. Paul.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Sept. 15. 201 Washington Building.
WESTERN RAILWAY CLUB.
Sept. 19. Secy., Clement F. Street, Chicago.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Sept. 20. Secy., L. V. Carmalt, Roanoke, Va.
COLUMBIAN ENGINEERING SOCIETY.
Sept. 19. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 19. Secy., R. H. Clark, Pittsburg.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Sept. 20. Secy., S. E. Tinkham, 36 Broomfield St.
NEW YORK RAILROAD CLUB.
Sept. 21. Secy., John A. Hill, Temple Court, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Sept. 21. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Sept. 21. Secy., C. F. Franson, Portland Block.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Sept. 21. Secy., S. A. Charplot, St. Louis, Mo.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Sept. 22. Secy., C. H. McLeod, Montreal, P. Q.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last paper goes to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The headquarters of Engineering News on the grounds of the World's Columbian Exposition are at Section K, Aisle 37, of Machinery Hall (central aisle, just west of the large water tank), and at Section U N, Posts 10 to 11 (office No. 9), of the Transportation Building Annex, at the west end of the Great Britain railway exhibit. For the convenience of subscribers and advertisers, it is announced that some member of the editorial staff of this journal may be found at the first-named office, in Machinery Hall, from 10 to 10:25 a. m., of each week day, and from 10:35 to 11 a. m. at the second-named office, in the Transportation Building; as also frequently at other times. Appointments may be made by calling at our downtown Chicago office in the Monadnock Building.

The Engineering headquarters, at Chicago, are at No. 10 Van Buren St., directly opposite the viaduct leading to the Illinois Central R. R. World's Fair trains, and to the steamboat pier, and but a stone's throw from it. The rooms are large and comfortable, and include reading, writing, smoking and other apartments. The rooms are to be kept open during the Fair by subscriptions of engineers, and all American and foreign engineers visiting Chicago are invited to register and make free use of the rooms during their stay, and to have their mail addressed there. An informal reception is held at these rooms every Monday evening from 8 to 10 p. m.

The steam turbine as developed by several inventors is attracting increased attention and continues to show remarkably good results in actual use. In our issue of Jan. 12, 1893, we reported some tests made on the Parsons (English) turbine by Prof. J. A. Ewing, of Cambridge University, which showed a feed-water consumption as low as 21 lbs. per HP.-hour, the work being measured by measuring the current and voltage of electricity delivered by the dynamo to which the turbine was directly connected. In the same issue we criticised Professor Ewing's report of the tests, in which he attempted to compute the steam consumption per indicated horse power from the consumption per electrical horse power in a wholly incorrect manner, and concluded by saying:

We are inclined to attach considerable importance to the remarkably good results obtained in the test, and hope that the element of doubt which still attaches to them may be dispelled by further tests made by experts of the highest standing, under conditions which do not call for so many dubious allowances.

What we then proposed has since been carried out, and we are pleased to lay the results before our

readers. A test was made by Prof. Alex. B. W. Kennedy on a turbine similar to that tested by Professor Ewing, but of somewhat larger power. The dynamo to which it was connected reached in the tests an output of above 200 E. HP. The steam consumption when the turbine was under a load of 145.5 E. HP. was 20.8 lbs. per HP.-hour. When under a load of 165 E. HP. this was reduced to 20.3 lbs. A load of 92 E. HP. increased the consumption only to 23.3 lbs., and even under a load of only one-fifth its normal capacity it used only 33 lbs. of steam per HP.-hour. These are practically about the same results as were reached by Professor Ewing, and confirm the statement that the steam turbine does not fall off in economy with a variable load in any such degree as does the reciprocating steam engine. We find no claims in Professor Kennedy's report to a great difference between the work done by the steam on the turbine blades and the output of the dynamo. That idea of Professor Ewing's, which we criticised in the issue above referred to, appears to have been permanently dropped. It can safely be said, therefore, in the light of these tests, that the Parsons turbine, when fairly loaded, can generate a horse power with between 20 and 21 lbs. of steam per hour at 100 lbs. pressure.

The steam turbine of Dr. Gustav de Laval, exhibited in the Swedish section in Machinery Hall at the World's Columbian Exposition, is attracting great attention from engineers visiting the Fair, and the judges contemplate subjecting it to a careful test to determine its economy. A description of this turbine, with mathematical computations of its efficiency, can be obtained by any of our interested readers by addressing Reinhold Hornell, K 22, Machinery Hall, World's Columbian Exposition. A report of a test of a 50-HP. de Laval turbine, made May 13, 1893, by two professors at the Stockholm Polytechnic and an inspector of the Board of Trade, showed a steam consumption of only 19.73 lbs. per HP.-hour. It will be seen that this is very close to the economy obtained in the tests of the Parsons turbine and goes far to confirm their correctness.

The turbine invented by Mr. J. H. Dow, of Cleveland, O., which we described at length in our issue of Feb. 27, 1892, has not yet been able to approach these very low records of steam consumption; although we believe its inventor is still at work with that end in view. In this connection it seems worth while to call attention to a novel idea proposed by Mr. Dow in a paper read before the recent aerial navigation conference. After calling attention to the great advantage of the steam turbine as a motor for flying machines on account of its great power in proportion to its weight, he said that the weight of the boiler necessary to supply it with steam was such a large item as to seriously handicap the turbine as well as every other steam motor for this especial work. To meet this obstacle he proposed that the steam turbine should be adapted to utilize the expansive force of gases precisely as a gas engine does. The absence of rubbing parts would preclude the necessity of lubrication and might even make it feasible to dispense with the water jacket, thus greatly increasing the economy of the machine. It is possible that the small specific gravity of the highly heated gases resulting from combustion might make it difficult to use them with economy in a turbine; but if trouble is not experienced from this cause, the idea appears to contain a very good hint to the inventors who are working to develop the steam turbine or the gas engine.

Some of the nicknames which are in common use in American railway circles prove serious stumbling blocks to foreigners. One of the most severely technical of our English contemporaries gravely informs its readers in a recent issue that:

The panhandled trestle and bridge over the Tuscarawas River, west of New Comerstown, O., has been completed. The entire bridge is 450 ft. long, each truss being 153 ft. Owing to the location, the high water and the nature of the ground, the work of building the temporary trestle was attended with a great deal of danger.

American engineers who are familiar with the Pittsburgh, Cincinnati & St. Louis Ry. will readily understand what a pan-handled trestle is; but it is

doubtless rather puzzling to English engineers to figure out what peculiarities in the design of a railway trestle can possibly be referred to by that term.

Mr. George R. Davis, the Director-General of the World's Columbian Exposition, in replying recently to a petition from the Association of American Exhibitors for certain reforms in connection with the administration of the Exposition, said that the fact might as well be admitted that some matters had been entrusted to the holders of concessions which had better have been controlled by the Exposition authorities. This frank admission must be conceded to cover a large share of the matters in which the Fair has been criticised. We wish to call attention to a single one of these matters now; not with a view to its remedy—it is too late for that—but that it may be recorded for the benefit of the managers of future expositions, great or small. We refer to the concession for the publication of the official catalogues of the Exposition. Experience at Chicago has abundantly proved that the publication of the official catalogues of exhibits should not be sold as a concession, at least without restrictions and requirements which have not been enforced there.

The public supposes the official catalogue of such a great international exposition as that in Chicago to be a correct and complete list of the exhibits in each department, properly classified. The official catalogues sold by the holders of the concession are neither correct nor complete, and the classification is unsatisfactory. The haste with which the exhibits were installed, and the many changes in exhibits made at a late date, give, of course, some excuse for these errors and omissions; but it is difficult indeed to find any excuse for the manner in which the concessionaire has been permitted to solicit and accept "puffs" for insertion under the entries of exhibitors. For example, in the catalogue of the machinery department a maker of boiler feed pumps has inserted after his name:

"Duplex steam pumps for boiler feeding. Hot or cold water. The best made. New plunger design. More improvements than any others."

A steam engine builder says:

"Manufacturer of automatic steam engines for electric lighting, electric railways, etc., giving the best regulation of any engine in the world."

Whether these statements are true or not, it must be plain enough to any one that they are wholly out of place in the official catalogue. The Exposition authorities would have no right, in publishing an official list of the exhibits, to say that one man's machine was better than his rival's. The publishers holding the concession have no more right, and the insertion of such statements is a fraud on the public and an insult to other exhibitors whose goods are thus compared unfavorably with their competitors.

That our readers may see on just what basis the holder of the catalogue concession has inserted these "puffs" we reprint the following circular which was distributed to the exhibitors in Machinery Hall a few weeks ago:

Chicago, Ill., U. S. A., July 26, 1893.

To Exhibitors Who Are Not Represented in the Official Catalogue with Additional Lines—The revised edition of the official catalogue for the Machinery Department is now issued in a complete form, with all corrections made. Before the pages are electrotyped, exhibitors may insert descriptive matter beneath their entries at the rate of \$5 per line for the first line, and \$3 for each succeeding line.

H. B. Conkey Company.

ACCELERATED TESTS FOR THE SOUNDNESS OF CEMENTS.

The so-called accelerated tests, that is, tests in which heat is employed either dry, as in the flame and kiln tests, or in connection with water, as in the hot water and steam tests, for determining the soundness of hydraulic cements, have hardly received the consideration among American engineers that they deserve. It is generally conceded that neither chemical analysis nor the usual tests for setting and tensile strength are of much value in determining the durability of a cement. The cold water test is consequently the only thing approaching a test for soundness to be found in 95% of the cement specifications in use in this country, and experience has proved this to be unreliable within

any period of time which the engineer has at his command. In European countries some further advance has been made in the line of tests for soundness, and many engineers are advocating and adopting heat tests of various kinds, although such tests have not received the sanction of common practice among European engineers as a body. These tests have also recently been taken up by some of the more progressive American engineers and investigated in connection with both Portland cements and our well known natural cements. Very few of the results of these studies have found their way into engineering literature, however, and for this reason the series of experiments by Mr. Fred. P. Spaulding, described on another page of this issue, are worthy of attention.

The most important quality of a hydraulic cement, not excepting its strength, is its durability, or as it is, perhaps, better termed, its soundness. It is of little moment whether a cement develops a high tensile strength in a few days or not, if in a few weeks or months it begins to crack and disintegrate and fall to pieces. In fact, if a cement proves itself sound and complies with the general properties of cements in respect to setting powers, it is amply strong in 99 cases out of 100 for any purpose for which it is likely to be used in engineering.

By the soundness of a cement is here meant its immunity against all destructive agencies within itself. Unsoundness is in the majority of cases due to an excess of lime in its composition, or to an imperfect combination of the lime with the silica and alumina. An over-limed cement quickly disintegrates or swells in sea water, owing to the dissolution of the lime by the salts therein, or to the formation of crystalline compounds with the sulphates in the water, and consequent expansion. The bursting of the cement through this expansion has received the name of "blowing," and a cement subject to it, of a "blowy" cement. There are, however, other causes than free lime for disintegration. Aluminate and ferrate of lime are among these, and will be spoken of further on. Sulphate of lime or gypsum is another, and magnesia still another. A cement may "blow" when exposed to the air, or when placed under water, but it occurs most frequently under water, and especially in sea water, and it may "blow" within a few hours after being gaged, or it may not give any indications of being unsound for several months. Disintegration or blowing may, however, be due to extraneous causes, such as the use of dirty water or a dirty sand, or other improper aggregate, or it may result from improper manipulation, the subjection of the green mortar to a severe frost, or one of several other causes. In these cases it is not necessary to point out that the cement may have no fault, but it may be pointed out that in the interest of both user and manufacturer, and in order that future disputes may be avoided, the absolute soundness of the cement should be determined before it is used. The question it is proposed to discuss briefly here, then, is: In how far can accelerated, or heat tests, either together or individually, be depended upon to determine accurately this quality according to our present knowledge?

In considering the availability of a new method for determining any combination of chemical and physical characteristics it is necessary to consider both the inherent probabilities in its favor and the proofs of actual experiments. The cement whose failure is most annoying and dangerous is the one which begins to disintegrate only after weeks, or, perhaps, months, in the structure. Evidently the only way unsoundness of this character can be determined, since a chemical analysis is of no value, is by accelerating the setting and hardening processes. There being nothing but a slow process of chemical combination, and such combination, being, as a rule, hastened by the presence of heat, it is argued by analogy that it will serve a valuable purpose here. Plausibility is given to this reasoning by the well known fact that heat, particularly moist heat, does hasten the hardening and setting of cement. It would seem to follow then that by applying heat artificially a cement might be made to show in a very short time the faults which it would otherwise take weeks to develop.

The question arises at this point as to whether the application of heat of considerable intensity

may not act to disarrange the chemical reactions which take place in the process of setting, and instead promote reactions tending to produce disruption or render inactive the cementitious properties of certain ingredients. For instance, it is stated (Eng. News, Dec. 5, 1891) that a heat of 200° F. destroys the cementitious properties of aluminate of lime. It is also well known that cement gaged with hot water will set quickly and give a high tensile strength in a short time, but finally decreases considerably in strength. Again, a sufficiency of water for chemical action is a prime necessity to the perfect setting of cement, both at the time of gaging and probably for some time after the so-called "permanent set." This being the case, the use of an intense dry heat as in the flame and kiln tests would seem to be injurious, as they deprive the cement of water just at the time when its presence is absolutely essential. The same objection would not apply to the hot water and steam tests, however.

As a rebuttal to the argument concerning the disastrous effect of heat upon the aluminate of lime, we have the statement of Bonami and other French chemists that aluminate of lime in a basic state is a direct source of expansion like free lime. Further, according to Dr. Wilhelm Michaelis, the German cement expert, only cements rich in silica and as poor as possible in alumina and ferric oxide are reliable in sea water, as both the aluminate and ferrate of lime not only are decomposed by sea water, but give rise to double compounds tending to destroy cohesion by producing bulges and cracks. Under the supposition that these two last statements are correct, and the reputation of the men making them is a good surety on that point, the heat tests are then of direct advantage in determining the quality of cement to be used in sea water.

Turning to the records of experience with accelerated or heat tests, a great diversity of results is observed. The experiments of Mr. Spaulding, before noted, show, that, with the exception of the flame and kiln tests, the heat tests recorded the failure only of those cements which ultimately disintegrated in cold water. Almost equally uniform results have also been obtained by several other experimenters. On the other hand, there is considerable evidence to show that often perfectly reliable cements are made to show unsoundness by heat tests. A somewhat careful examination of the available data, however, indicates that with the milder moist heat tests, the number of such results is quite small, compared with the number in which the character of the cement is correctly indicated.

Leaving the record of actual experiments for the opinions of the experimenters, we find a similar diversity of opinion as to what constitutes a proper heat test. M. Deval, the French writer, advocates the immersion of a pat of neat cement in water at 80° C. (177 F.) and asserts that if it disintegrates the cement is unsound. Mr. Henry Faija, (the English engineer, recommends a vapor bath at about 100° F., until the cement in the pat sets hard and then the immersion of the pat in water at from 112° F. to 117° F. for 12 or 15 hours, and states that his experiments show that the temperature advocated by M. Deval is unnecessarily great and that many good cements will fail under it. He also states that he has found that he can blow any cement to pieces if it is subjected to a temperature of 180° F. long enough. This statement must be accepted with a reservation as to what time is "long enough," however, for there are brands of Portland cement which have been boiled (212° F.) for two weeks and exhibited no signs of failure. Dr. Titmayer, of Zurich, proposes placing the pat of cement after 24 hours in water and gradually raising its temperature to 120° C. In addition are the flame test of M. Candlot, the high pressure (10 to 15 atmospheres) steam test of Erdmenger, the boiling test of Michaelis and the hot water (200° F.) test of Maclay.

In view of this confusion of ideas and testimony it must be admitted that the engineer in search of a reliable test for soundness is partly excusable for concluding, as one author has tersely said, that: "There is at present only one way of determining whether the judgment passed on a cement by any system of testing is sound, and that consists in waiting half a century to see how

the work stands." To come to such a conclusion, however, would be a great mistake, as a careful sifting of the evidence will, we believe, show that the theory of heat tests has much in its favor.

From Mr. Spaulding's tests (Table II.), before mentioned, it will be seen that with the exception of the flame test, the several accelerated tests rejected only those cements which ultimately (one of them after nine months) failed in cold water. The failure of the flame test to give as reliable results as the others is an indication that the statement before made, that this test is likely to act injuriously by dehydrating the cement is correct. It will be seen also that the only other dry heat test, viz., the kiln test, gave unreliable results. Both inherent probabilities and experience appear to show the flame and kiln tests to be not only too severe, but wrong in principle. The objection of dehydration cannot be brought against the moist heat tests, however.

As far as present experience can warrant a decision it would seem that some form of the moist heat test will be the result of the evolution of the heat test. The presence of moisture is probably the prime element of the success of the hot water and boiling tests, as far as the determination of free lime is concerned. It seems entirely probable also that a moist heat of moderate intensity, say, under 150° F., may prove to be as efficacious as a boiling heat (212° F.), or as steam under 15 atmospheres pressure (390° F.) in determining soundness. In fact, the originator of the high-pressure steam test, Dr. Erdmenger, advocates its use chiefly for the determination of magnesia, and it has been discovered entirely possible to determine the presence of over 5% of magnesia by the boiling water test. Mr. Faija's tests, which have been quite commonly and successfully used in England, require a temperature of not over 117° F. The fact that in introducing heat we are introducing an element always absent from the normal conditions accompanying the setting of cement, and of whose action we are not entirely certain, would seem to counsel caution in adopting high temperatures until moderate temperatures had been proved insufficient.

As the evidence now stands the heat test can only be considered as in the process of evolution. Most of the experiments yet made have been limited in their scope, and although they afford gratifying evidence of the value of heat tests, they cannot be correctly assumed to have given conclusive results. The hot water test, and in this water at considerably lower temperatures appears to be quite as good as boiling water, does successfully indicate the presence of free lime, and in this respect is very useful. A cement which resists well a hot water test of 180° is pretty certain to be free from uncombined lime. The hot water test is also undoubtedly useful in showing other causes of unsoundness than free lime. We may conclude from the evidence presented that no cement should be used in sea water which cannot resist the ordinary hot water test. It may be that such a cement would prove sound and reliable, but there are grave doubts against its doing so. What is needed to put the question of accelerated tests beyond doubt is a long series of regular heat tests of resistance by the side of cold tests of resistance, as has been done on a small scale by Mr. Spaulding. A consistent comparison could then be made and the question put on a scientific basis by studying closely those cements in which these two modes of testing give divergent results. Another point which needs to be investigated further is the applicability of heat tests to natural as well as Portland cements. Such experiments as have been made indicate that they work equally well with either class of cements, but their number is too small to determine this conclusively.

In closing, it may be pointed out that often too much is required of a cement. Probably three-fourths of the failures of cement in sea water could have been prevented by greater care in making the mortar or concrete and in placing it in the structure. By far the greatest use of cement in sea water is in making concrete and the most disastrous failures in marine structures have been with this material. Of course, failures caused partly by the force of the waves are excepted in this statement. A concrete made of a comparatively poor cement

will withstand the disintegrating action of the sea water if care is taken to make it impervious to the water. This can easily be done by putting on a skin of cement mortar or rich concrete, and in several other ways. As Portland cement is now manufactured, it contains of necessity free lime in greater or less quantities, and this should be considered in specifying cement for any particular use, and care taken not to demand extravagant requirements in this respect unless the magnitude and character of the work require it.

LETTERS TO THE EDITOR.

BRAKE FAULTS ON ENGLISH RAILWAYS.

Sir: We note the reference to brakes in your issue of July 20, and send you herewith a card showing the number of failures of each class of brake per mile run during the last half of 1892.

Yours faithfully, Alfred Louis Sacre,
Managing Director, the Vacuum Brake Co., Ltd.

(The inclosure shows in substance that the Westinghouse brake averaged one "fault" per 93,785 miles run, while the automatic vacuum brake averaged one for every 182,308 miles run. To get at the real significance of these figures, however, it must be understood that the Board of Trade classifies as a "fault" of the brake apparatus everything which causes delay to a train, even though the delay be not more than two or three minutes. On looking over the Board of Trade reports we find that a very large proportion of the "faults" charged to the Westinghouse brake were delays due to burst hose, very few failures being due to other parts of the brake apparatus. The percentage of failures due to burst hose is much smaller with the automatic vacuum brake, and the failures due to defects of the apparatus or mistakes in handling it are correspondingly greater. As the Westinghouse brake carries a much heavier pressure than the vacuum brake, the reason why it should be more likely to have hose bursts is apparent. The statistics show, we should think, that a somewhat heavier hose should be used on the Westinghouse trains.

It is fair to say in this connection that not a single accident causing injury to person or property, due to failure of brakes, was reported in the six months, a very good showing for both the brakes.—Ed.)

THE CRANE AIR-SAVING RESERVOIR FOR AIR-BRAKE PUMPS.

Sir: In looking over, in the last issue of your paper, the article on air-brakes and the World's Fair exhibits, something attracted my notice about which I should like the privilege of saying a few words. The statement made which I wish to criticise is concerning the Crane Company's "Air Saving Device," and is as follows: "It may be questioned whether in case this valve should be stuck down (referring to the safety valve) an accident might not be caused from the failure of the brakes to operate." A more careful study of the device will, I think, show that this danger is purely imaginary because of the fact that the emergency exhaust port has not been interfered with at all, so that by simply moving the handle to the emergency position all the pressure can still be exhausted from the train-pipe even though the small reservoir should be closed tight.

Yours sincerely,
Paul Synnstedt.

Chicago, July 26, 1893.

(The Crane Co.'s catalogue does not mention the fact that the exhaust from the emergency port does not pass to the air-saving reservoir, and we overlooked it in examining the device. With the device arranged in this way there appears to be no possibility that it could in any way injure the reliability and certainty of application of the brakes.—Ed.)

CONCERNING LOW BIDS FOR PROFESSIONAL SERVICES.

Sir: I read with much interest your editorial comments in reference to the unreasonably low rate some engineers place upon their work, as illustrated at certain recent lettings of engineering work. In the outset I think your comments were incomplete without some allusion to the certainly unprofessional method of securing work by competitive bidding, but so long as this method is countenanced and participated in by engineers of the highest standing, just so long are the younger members of the profession at liberty to follow their example.

You cite two cases where the disparity between the highest and lowest bidder is so great as to display on the part of some of the competing engineers ignorance of one kind or another. Being familiar with both cases I can perhaps throw some light on the subject, which, in a measure, will explain the wide difference in the bids.

The first case cited was not a recent one, as bids were received last November. Here the bids varied from \$4,000 to \$290, but not "for identical work," and the bidders were notified that there were on file maps, plans, profiles, etc., which, however, the city would not guarantee. Many took it for granted that these were valueless, but an inspection of them showed the writer that these plans and profiles were thoroughly reliable, having been made from actual surveys by J. Foster Flagg, M. Am. Soc. C. E., some years ago, and all that was necessary was to bring them up to date, a matter of a few days' fieldwork.

For an engineer to ask \$4,000 for simply designing a system of sewers for a city of this size, having most of the data at hand, is quite as ridiculous as to attempt to make complete transit surveys, plans, profiles and designs of a system for \$290. The council realized that due weight had not been given to the existing data, and readvertised, when bids were received varying from \$1,500 (including advice previously given) to \$400. Before readvertising, however, the opinion of a non-competing engineer was asked, who stated that the work was worth about \$500.

At the second place referred to, if I am correctly informed, the specifications for the required work were very artfully gotten up by one of the engineers who intended to bid on the same, and who informed me before letting that they "had the thing fixed." On the face these specifications showed much more work than was actually required; for instance, they implied that stone monuments would have to be placed at all street intersections for bench marks; what was required was simply the establishment of benches on stone sills or otherwise at all street corners. This ruse acted very well on some of the bidders as evidenced by the high prices asked. Before the work was let the question of additional water supply demanded the attention of the council and the sewerage plans were shelved. Engineers were asked to submit bids for making the necessary surveys, plans and specifications for the water supply improvements, involving an expenditure of \$75,000 to \$100,000.

The writer presented a proposition, but was given to understand that it could hardly be accepted, as a bid had been received offering to do the work for nothing and pay the city whatever expense the preliminary surveys made by the city engineer had cost them (\$100 approx.) providing their proposition for sewerage plans was accepted. As my bid for sewerage plans was based on my experience at two other cities, the plans for which I had just completed, I could not afford to make such a tempting offer, and so the work went to the other man. This proposition was made by a firm of engineers whose bids in both cases were above the average. Would this method of securing work indicate intelligent and honorable bidding?

There are circumstances in which low bidding is excusable; for instance, if A, a man of wide experience covering many years of actual practice, is bidding on work in competition with B, a young man, is it to be supposed that, if their bids were equal, B would stand any chance of securing the work? I think not. The experience to B is valuable, his services per day are worth perhaps one-quarter of those of A, so that if A asks \$1,000 for the designs, B would be handsomely rewarded by a much smaller sum.

If B comes out squarely and acknowledges that his experience as a designing engineer is quite limited, but wants the work for the reputation he can gain thereby, I can see no harm in his taking just as low a figure as he thinks he can afford to do it at, with a fair percentage of profit. This, however, does not excuse engineers of standing offering to take work at ridiculously low figures.

Why some engineers fail to secure work even when they have more experience and will work cheaper than others, is that, instead of confining their efforts to showing themselves capable, they try to secure the work by minimizing the ability of other competing engineers. The average councilman is not so glib as to swallow these reports, and such conduct often reacts with force upon the slanderer.

Although, for reasons satisfactory to myself, I have bid very low on some work yet it so happens that in no city or town where I have designed or am at present constructing work was I the lowest bidder, but nevertheless must take issue with you in your conclusion that an engineer whose chief fault is his youth (for give him time and he will get over that) cannot perform just as good service as many engineers who have had much more experience.

The young engineer who enters the field with a determination to win need not take chances as to errors in judgment when the best class of consulting engineers stand ready to examine, revise or approve of his plans. What this consultation and approval will cost depends largely upon the neatness and accuracy of plans, and judgment displayed in the designs and completeness of details. The cash value of this personal contact for a day or so at a time with such men as Mr. Hering, sanitary engineer, in sewer work, and Cooper, in bridgework, is inestimable.

Yours truly,

Alexander Potter,
Assoc. M. Am. Soc. C. E.

New York, Aug. 19, 1893.

THE BREAK IN THE RESERVOIR AT PORTLAND, ME.

Sir: In your issue of Aug. 17 Mr. J. P. Frizell, M. Am. Soc. C. E., takes exception to the theory which has generally been accepted here as to the breaking of our reservoir, making the broad assertion that "any supposition of the creeping of water along these pipes and gradual wearing of an outlet is inadmissible." His theory is that the reservoir failed on account of a light bank. He says: "There was practically no width at the top. The rupture took place at an angle, the junction of two contiguous banks, which had here their maximum height of something like 44 ft., the banks failing here at its weakest point on account of the inability to undergo the deformation necessary to the development of its full strength without a strong tendency to separate along the diagonal forming their line of junction."

In answer to his claim that "there was practically no width at the top," it simply becomes a question between his idea of "no width" and his source of information. The greatest depth to which the clay puddle sloughed was 3 ft. The wall at the water line is 27 ft. thick. Call 5 ft. of it useless and there is still 22 ft. left. Is that "practically no width at the top"? Were Mr. Frizell's theorizings and data correct there is no doubt but that the reservoir would fail at the corner where the embankment was highest, and he claims that it did. Unfortunately for his theory, however, his source of information leads him astray, for instead of a 44-ft. embankment at the corner there was, after removing the top soil, only a 30-ft. embankment to build, 5 ft. of this being above the water level, thus leaving only 25 ft. of head, not 44, or even 39 ft. Further, the embankment at the next corner north of this is actually 9 ft. higher, giving a pressure head of 34 ft., as against 25, and this is the corner which should have gone out if Mr. Frizell's theory is right. Again, Mr. Frizell's source of information leads him to theorize that the banks would "separate along the diagonal forming their line of junction." There was no such diagonal. Each corner had and has a conical surface which was of appreciable radius at the height of 15 ft. above the bottom. Now, Mr. Frizell will admit that a circular embankment is stronger than a straight bank of the same thickness. If water thrusts on the normal—which must be if the theory of the pushing apart of two walls meeting at an angle is correct—the water acting on the conical surface where the break occurred had at least double the weight of earth to overcome that the water at the sides had? Is this weakness? The change from the tangent plane to the conical surface may possibly be a source of weakness, but the "deformation necessary to the development of its full strength" would readily adjust itself, in my opinion. As far as the simple pushing aside of the "two contiguous walls" is concerned, I believe that the weakness due to the overflow pipe is more than balanced by the extra weight of the wall. If the high, weak wall and joint theory is to be accepted, the reservoir would have failed at the north corner, and at the joint (?) between the tangent plane and the conical surface, and not in the center. I may add that that and two other corners still stand, and that the lining, far from showing a tendency to separate along the diagonal, is in better condition upon these corners than anywhere else, the corner linings being practically "in place" from top to bottom. If Mr. Frizell's theory is correct the corners ought to be in the worst condition. In fact, they are in the best. Two sides still stand in fair shape.

Now what is an exact science? Euclid has been said to be the only author who is accepted by all as exact. An ex-President of the Am. Soc. C. E. once told a few of us understrappers that we were all right in hydraulic problems if results came within 10% of estimates. If 10% is allowable in water, what is allowable in clay, gravel, etc.? And can reservoir construction be called at this date an "exact science"? I more than doubt it.

The question as to whether 1½ to 1 is strong enough

for a reservoir wall I leave to my betters, but I do contend that the present break was in all probability caused by the action of frost followed by water working along the pipe and surcharging the earth inch by inch as it progressed, and finally breaking through and destroying the embankment. And I have endeavored to point out the weak places in Mr. Frizell's theory which tend to make it as "inadmissible" as he says our theory is. Very respectfully,

Percy H. Richardson.

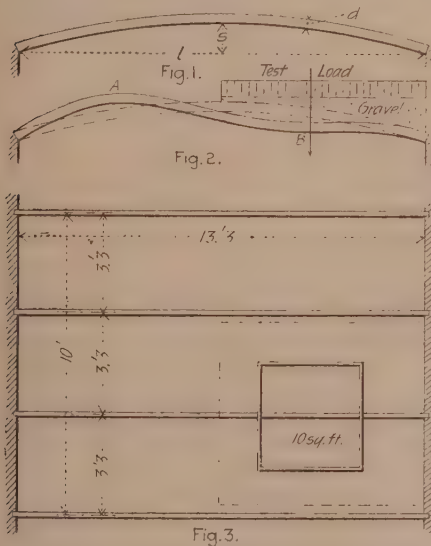
Portland, Me., Aug. 21, 1893.

AUSTRIAN TESTS OF CONCRETE ARCH SYSTEMS.

Sir: Some very interesting comparative tests were made upon the merits of different kinds of arches early in the present summer under the direction of the Austrian Society of Engineers and Architects. These tests consisted briefly in constructing a number of floor systems and loading them to destruction and measuring the deflection under different loads. Below is given the results of the tests on (1) common brick arch; (2) concrete arch; (3) concrete arch with iron rods on the intrados (Monier system); (4) concrete arch with imbedded I-beams (Melan system).

Kind of arch.	Span, ft.	Rise, ins.	Thickness, ins.	lbs. per sq. in. breaking load.
Brick.....	13.3	15%	6	321.5
Concrete.....	13.3	15%	4	737.5
Monier.....	13.3	15%	2%	839.7
Melan.....	13.3	11	3%	3,360

The Melan arch (Fig. 1) consisted of steel I-beams $3\frac{1}{2}$ ins. high and 1 to 5 concrete just one year old. To concentrate the load upon a certain point on the beam, as point B, Fig. 2, a wooden frame with a funnel-



Construction of Concrete Arches Tested for Crushing Strength.

shaped hole was constructed, and this hole filled with gravel and loaded on top. This arrangement is clearly shown in Figs. 2 and 3. As will be seen, the rib on which the load was concentrated broke under a load of 3,360 lbs. per sq. ft., leaving the other ribs unharmed. The high resistance was a surprise to the promoters. The chief advantage of the Melan arch is that it is as stiff at point B as at point A, while all the other systems gave way first at point B on account of the very low resistance against tension at point A. It may be said that these figures are the official figures of a board made up from members of the society mentioned, especially interested government officials and others. The full report of the board will probably be published this winter.

Friedrich Edler von Emperger,
Mem. Austrian Soc. C. E.

New York.

A disastrous fire occurred in the lumber district of Minneapolis, Minn., on Aug. 13, resulting in the death of five persons and the destruction of over \$1,000,000 worth of property. The burned district covers the lower half of Nicollet Island, fronting the main channel of the river, all of Boom Island, and a strip bordering the east side of the river from Boom Island to 22d Ave., fully a mile in length and from a quarter of a mile to 40 rods in width. This section is the center of the great lumber industry of the city, and almost the entire loss is confined to the lumber mills and various woodworking establishments. The cause of the fire is not definitely known. The insurance will amount to about \$800,000.

AN ENGLISH VIEW OF AMERICAN RAILWAYS.

The visits of foreign engineers and railway men to this country, in connection with the World's Columbian Exposition, will undoubtedly have an educational effect which will result in the improvement of foreign railways and railway service. As we have more than once had occasion to point out, Englishmen (and foreigners generally) still hold to the idea that American railways are of light and rough construction, and we have taken occasion to present actual facts in comparison of English and American railways. English railway men are already beginning to see the superiority of American rolling stock, and are gradually abolishing the three-class system and introducing parlor cars, sleeping cars and dining cars, the latter even for the long disregarded, though most lucrative third-class traffic, as pointed out in an article on the new Midland Ry. dining cars in our issue of July 6. We print below a letter written by Mr. Clement E. Stretton, a well known English engineer, to "Engineering," of London, which will probably surprise a good many of the readers of that paper. Mr. Stretton has investigated much and written much in regard to railways in England, and was largely instrumental in getting for Major Pangborn the information needed for the splendid historical exhibit of locomotives made at the World's Columbian Exposition by the Baltimore & Ohio R. R. With this introduction we leave Mr. Stretton's interesting letter to speak for itself:

The object of my recent visit to America was to enable me to examine and study the system of construction and practical working of the railways of that country, and especially to see the vast collection of engines, vehicles and appliances which has been placed in the Transportation Department of the World's Fair at Chicago. Every possible facility was courteously granted by the officials of the various railway companies and by firms and owners of works connected with railway appliances. Thus opportunities were afforded of seeing the manufacture of every separate part of locomotives, cars, brakes, signals, permanent way; also the construction of bridges and station roofs.

Introduction.—In the early days of railways in America it was necessary to make lines of very great length, passing through blank country having little or no local traffic. The track was, therefore, laid as quickly and as cheaply as possible; the stations, buildings and bridges were also of the same rough-and-ready construction. The object of these early lines was to bring vast districts of unused country into cultivation, and to promote the building of towns and the introduction of various works. Englishmen appear to be under the impression that the railways are still of the former rough construction. This is, however, not the case. The old light rails have been replaced by heavy steel rails weighing 80 lbs., 90 lbs. and 100 lbs. to the yard. The early wooden bridges have given place to some very fine structures of iron or steel. Large numbers of new stations have been erected and others are under construction, many of these being quite as large and convenient as the best of those on this side. It may here be mentioned that American trains run upon the right-hand side of the line, and the signal-arms are upon the right side of the posts.

Fares.—The railway companies provide only one class of passenger car, and issue one class of ticket, known as the "first-class," but all the important trains have either Pullman or Wagner drawing-room, dining, or sleeping cars attached, for riding in which a small extra charge is made and paid to the car conductor (if a car ticket is not purchased at the company's office provided at important stations.—Ed.). The passenger fares for the "one class" are cheaper than the penny per mile (2 cts. per mile.—Ed.) charged in this country, and the extra charge paid for the Pullman cars is considerably less than our first-class fare.

Cars.—The cars are all of the American pattern, having doors at the ends, and consequently a communication throughout the train. They are all supported on two bogies, each having either four or six wheels, according to the weight of the vehicle. The length of the ordinary car varies from 52 ft. to 70 ft.; the Pullman cars, however, are considerably longer, some of the latest being no less than 80 ft., and all have two six-wheeled bogies. The extremely long journeys which have to be made in America have always necessitated an amount of luxury and comfort which has not been so much required in this country, and which it is quite impossible to obtain so long as the separate compartment system of carriage remains in use. Within the past few years numbers of American visitors to this country have protested against the construction of the English compartment vehicles, and English visitors who have been to America have re-

turned home greatly impressed with the luxury and comfort of traveling in American trains. The result has been that several of the English railway companies have introduced various "carriages with corridor," "twin saloons," and "lavatory coaches." These are all important steps in the right direction, and tend to the abolition of the separate compartments, but it must be admitted by all impartial observers that for luxury and comfort the best American trains are to-day still far ahead of the best English trains.

Speeds.—Since the great railway race of 1888 little or no alteration has been made in the speed of trains in Great Britain, whereas in America important accelerations have followed each other so quickly that speeds are now run in that country as high, and even higher, than those attained here. Trains on the New York Central, Pennsylvania, Baltimore & Ohio, and Philadelphia & Reading railways run at very high speeds and maintain very good time. For a long-distance journey it is interesting to note the working of the "Empire State Express," which leaves New York at 8:30 p. m. and arrives at Buffalo at 5:10 p. m., a distance of 440 miles in 8 hours and 40 minutes, including four stoppages.

To compare with this, we, of course, turn to our fastest "Flying Scotchman," which runs from London to Edinburgh, 400 miles, in 8 hours 25 minutes, the result, however, being in favor of the American train, as it performs a distance of 40 more miles with an increase of only 15 minutes in time, and it is also a heavier train. An article which appeared in the "Times" of Monday, July 3, refers very clearly to the present position, thus:

"For the last year or two it has seemed as though the blue ribbon for speed, which England has held unchallenged since the beginning of railway history, was to be surrendered tamely, without a struggle, to our American cousins."

Many English railway chairmen and officers are now in America, and it is probable that on their return the speeds of certain trains will be increased so as to regain the "blue ribbon," and to prevent the Americans continuing to have the right to advertise certain of their express trains as "the fastest regular passenger train in the world."

Locomotives.—The standard American express engine has a four-wheeled leading bogie, outside cylinders, and four coupled wheels, and carries the usual "cow-catcher" in front, large headlight to illuminate the track in order that the driver may see the line for some distance ahead, the bell to warn persons at stations and crossings and has a very comfortable cab provided for the men. To English eyes the American engine looks a peculiar and vast machine, but, of course, the test of a locomotive must ever be the practical work it performs. The American boiler is extremely large, and supplies an ample amount of steam; it is placed at least 1 ft. higher than in an English engine, the total height to the top of the chimney being no less than 15 ft. It follows, as a matter of course, that locomotives having cylinders 20 ins. in diameter, a stroke of 24 ins., driving wheels of either 7 ft. or 6 ft. 6 ins. in diameter, supplied by large boilers having fireboxes 10 ft. in length, and a steam pressure of 180 lbs. per sq. in., must be, and are, capable of performing very heavy and fast work.

During my visit to America I timed the running of most of the important trains in which I traveled, and by the courtesy of several companies was enabled to ride many hundreds of miles upon the engines working various kinds of trains. On some of these journeys the engine, conveying a load of 250 English tons, ran 60 miles in 68 minutes, and on falling gradients miles were passed in 50, 46 and 45 seconds, several miles together being covered at a speed of 80 miles an hour. Between Philadelphia and New York, and between Philadelphia and Atlantic City, I had ample facilities for watching the practical working of the four-cylinder compound locomotive designed by Mr. Vauclain, and built at the celebrated Baldwin Works. Facts, such as running 56 miles with a train of six Pullman cars in 50 minutes, speak for themselves, and when my records show miles accurately timed in 44 seconds (that is equal to 81.8 miles an hour) it must be admitted that the engines perform some good work. Considering that the gauge is the same as our own, and the boiler placed much higher, it might be supposed that that the riding at high speed would be uneasy. This point I specially observed, and found that at a speed of 80 miles an hour the working of the engines was remarkably steady, and the absence of any long rigid wheel-base enabled trains to be run round sharp curves at speeds which would be perfectly unsafe with rigid engines and vehicles.

Brakes.—When the high speed and heavy trains are taken into consideration, it will be seen that very efficient brake power is absolutely essential to safety. That is amply provided, as every engine, tender and passenger car in the country is fitted with the best of all continuous brakes—namely, the Westinghouse automatic. Not only do the American companies apply brake blocks to every wheel in the train of cars, but

they are now engaged in fitting brakes even to the leading bogie wheels of their engines, so that, as they say, "every wheel which carries weight may have its own share of stopping power." They are also applying the same brake to large numbers of goods vehicles.

Goods Traffic.—An ordinary English goods wagon weighs usually about $5\frac{1}{2}$ tons, and carries a load of 8 or 10 tons, the proportion of deadweight to paying load being considerable. An American wagon is 38 ft. long, runs on two bogies, weighs about 11 tons, and carries a paying load of over 26 tons. The standard goods engines have eight coupled wheels, cylinders 19 or 20 ins. in diameter, and a steam pressure of 180 lbs. When riding on one of these powerful locomotives it conveyed a train of 70 freight cars. The vast volume of railway traffic enables it to be cheaply conveyed, consequently the rates for goods are less than in England, and there can be no question that much of the commercial success of America is due to its cheap goods and mineral rates.

Many of the important companies have lately made considerable progress in the adoption of the block system and in the use of efficient signals; however, an immense amount still remains for the American engineers to do in that direction. Railways frequently cross each other on the level and pass over roads and streets, the only warning to the engine-driver being given by a hand-lamp or flag. Facing-points often exist which led into sidings, and I saw numbers of such, totally independent of and unlocked with any signal. In running, therefore, very much has to be trusted to the quick eye of the driver and the power of his efficient brake. From these few remarks it will be seen that the English can learn much from America relating to comfort in traveling, but that as regards fencing of the track, gates at crossings, bridges over or under the line and the extended use of the block system they have much to copy from England.

THE MACKAYE SPECTATORIUM.

The Mackaye Spectatorium at Chicago was to have been a kind of elaborate panorama representative of the life of Columbus and the discovery of America, and having very extensive stage machinery for the moving scenes and for scenic effects, but financial troubles led to its abandonment some time ago. The immense building on 56th St., occupying a space about 600-ft. square, and 270

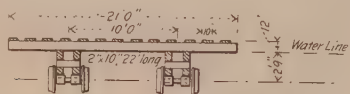


Fig. 1. Movable Platform for Mackaye Spectatorium.

ft. high from foundation to dome, stands unfinished, and will soon be torn down; but it is one of the most conspicuous landmarks about the Fair, and some account of what it was to have been will be of interest to many inquirers.

Besides its vast stage, it was to have included a cafe, restaurant, roof garden, etc. The rear of the building is a semi-circular chamber, the surface dimensions of which are over 100,000 sq. ft. The cost

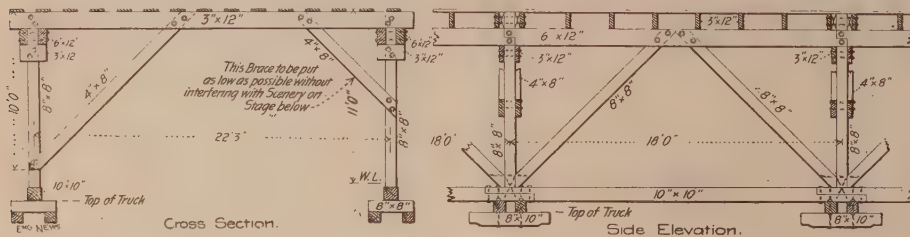


FIG. 2. FRAMED MOVABLE PLATFORMS FOR MACKAYE SPECTATORIUM.

of the mechanical equipment alone was estimated at \$600,000. The scenic effects included 22 movable stages. The frame of the stage picture was to be 150 x 70 ft., and the full range of the public at the horizon of the picture over 400 ft. It required over six miles of railway track for these stages to move upon, and their aggregate weight was over 1,200 tons.

Mr. Ralph Modjeski, of Chicago, the engineer in charge of foundations and the other engineering work, states that the framework of the building proper is practically finished except the dome. The roof trusses are erected and a portion of the roof is

covered. A portion of the building is covered with "staff" outside, and a little plastering has been done in some of the rooms. As to the auditorium, nothing has been done yet. In the tank or stage proper, which was in his charge, there were about 800 piles driven, most of them cut off, and some of them capped. The trucks which were to carry the rolling platforms are all finished and stored in the building. It may be stated that the project was for a sort of idealized "tank scene," with elaborate effects.

The foundations for the tracks were on piles arranged on radial lines, spaced 6 to 8 ft. apart in a radial direction and 11 to 12 ft. apart on the circumfer-

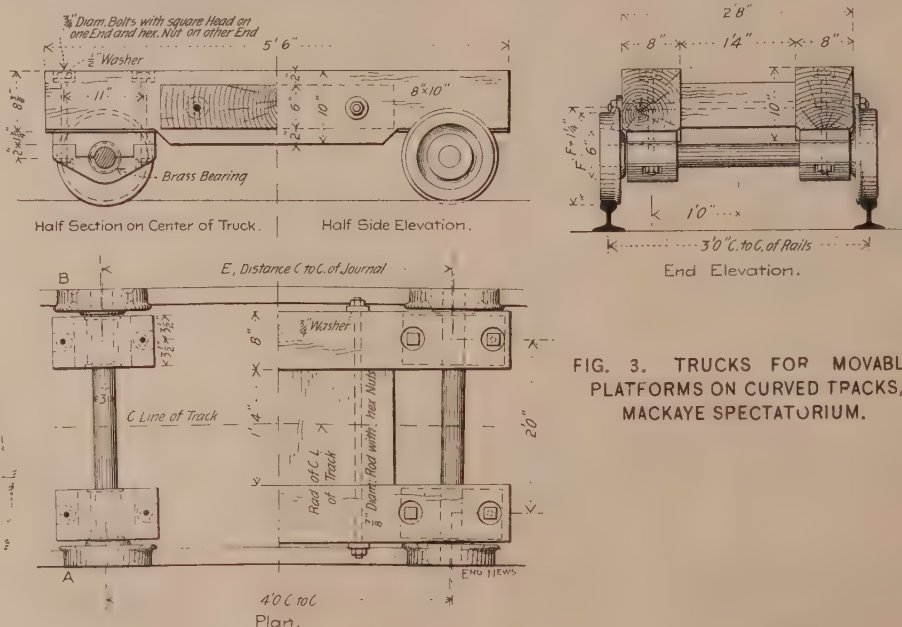


FIG. 3. TRUCKS FOR MOVABLE PLATFORMS ON CURVED TRACKS, MACKAYE SPECTATORIUM.

ence. The piles were to be cut off at 0.2 to 0.7 above datum, with a uniform slope of about 1 in 260 in the radial direction, and on them were to be caps laid in the same direction, with stringers on top laid in concentric circular curves, and covered with 3-in. plank, forming a conical floor having its axis in the center of the building.

The center part of the building is of 134 ft. 3 ins. radius, and outside of this is a segmental space 130 ft. wide, fitted with 19 tracks of different lengths and different distances apart, ranging from 141 ft. $7\frac{1}{2}$ ins. to 258 ft. 6 ins. radius on the center line. The tracks were to be 3 ft. gage c. to c. of rails, laid with 40-lb. steel rails bent to the exact curves required.

There were to have been 19 moving stages, containing about 135,000 ft. B. M. of timber (exclusive of planking), 12,000 lbs. of wrought iron in

drift bolts, machine bolts and rods, and 7,000 lbs. of cast iron in washers and castings for trusses. The stages were to have been 5 ft. 6 ins. to 40 ft. wide and 98 ft. to 150 ft. long. Some of them were to be mere platforms, Fig. 1, and others were to be framed structures, as shown by Fig. 2. These movable stages were to be carried on four-wheel trucks of the pattern shown in Fig. 3. There were to have been 192 of these trucks, from 4 to 14 to each track, according to the length of truck, with axles placed radially (4 ft. c. to c. of journals on inner side of curve) and wheels of varying diameter.

EFFECTS OF THE CURRENCY STRINGENCY.

The list of industries which have been placed in receivers' hands steadily lengthens, but the improvement in the general financial outlook gives reason to hope that brighter times may be near, so that the many firms who, with ample assets, are cramped for the money to meet pressing obligations may not be forced to the wall. Two large iron and steel making establishments in the East have been added to the long list of Western steel mills which have succumbed. The Oliver Iron & Steel Works of Pittsburg, was placed in charge of its president and chief stockholder, Henry W.

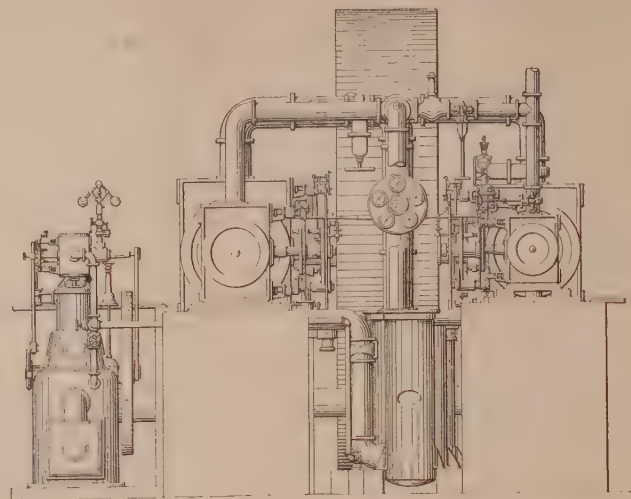
Oliver, as receiver, on Aug. 17. The company operated 123 puddling furnaces, with a capacity of 120,000 net tons per annum, and two Clapp-Griffiths open-hearth furnaces, turning out 48,000 tons of ingots. It also leased the Eagle Rolling Mill & Tube Works in Allegheny. Iron and steel plates, angles and structural shapes, muck-bar, skelp iron, bar iron and hardware were among its products. It also operated two blast furnaces, one at New Castle, Pa., the other in Allegheny.

The Troy Steel & Iron Co., which is also in a receiver's hands, has operated the Albany Iron Works with a capacity of about 37,000 tons per annum of bar iron, car axles, fish-plates, bolts and nuts, etc., and the Rensselaer Iron Works, with a complete steel rail plant and merchant mill, its capacity being about 300,000 net tons per annum. The Bessemer plant at this place was among the earliest built in the United States, but its distance from fuel supplies has for many years seriously handicapped it in competition with the Pennsylvania mills. The Oliver works, it will be noted, was more important as a producer of iron than of steel. The fact is being emphasized in these times that the day of the puddling furnace as a producer of profits is past.

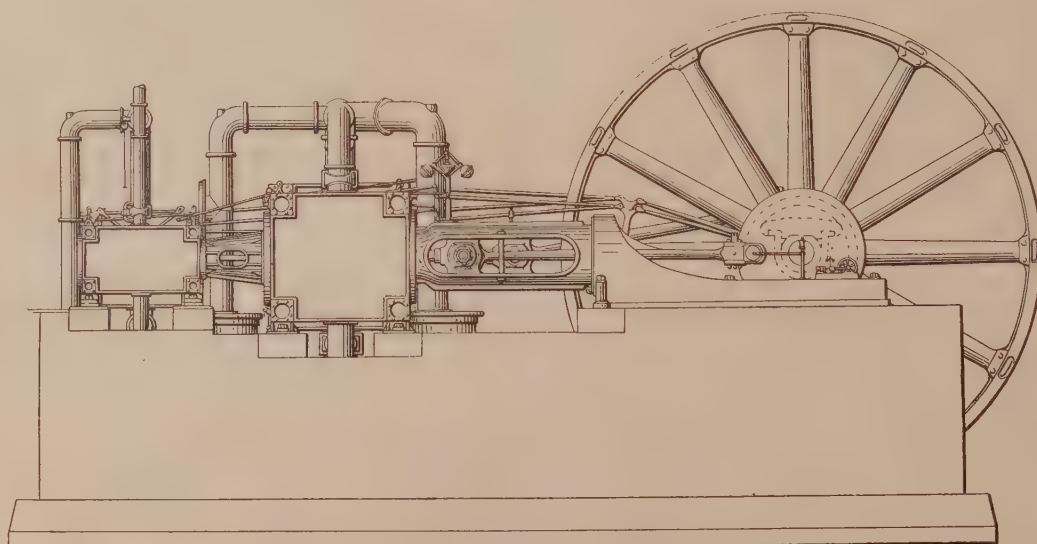
The Gilbert Car Works is another Troy corporation which has been taken possession of by the courts. As our readers know, this company has made a specialty of high-class passenger car work. It is now building the cars for the Lake Street Elevated at Chicago, and has a contract for 100 cars for the Manhattan Elevated.

The Eppinger & Russell Croosoting Co. is another firm, whose assignment is announced, with which many of our readers are familiar. The company suffered serious loss by an extensive fire a year or more ago, and it may be that its losses then left it ill-prepared to meet the present times.

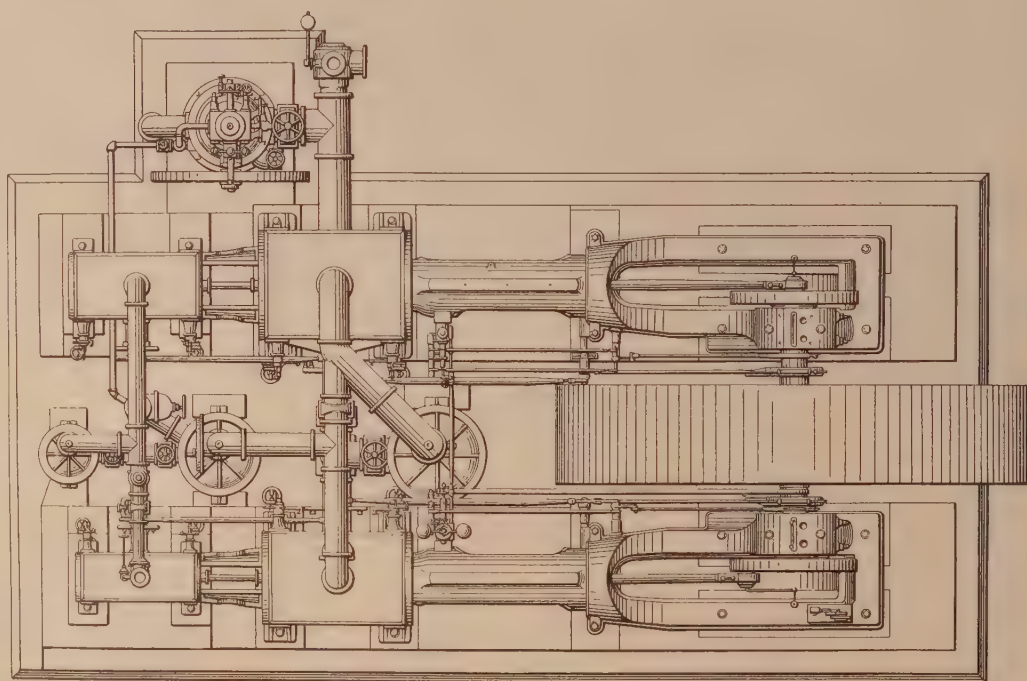
The Erie and the Northern Pacific are the only two great railway systems which have succumbed thus far to the financial stringency. Each corporation has been carrying a heavy load in the shape of a floating debt, and the present scarcity of currency, and in the case of the Northern Pacific heavy falling off of traffic, have been merely the



End Elevation.

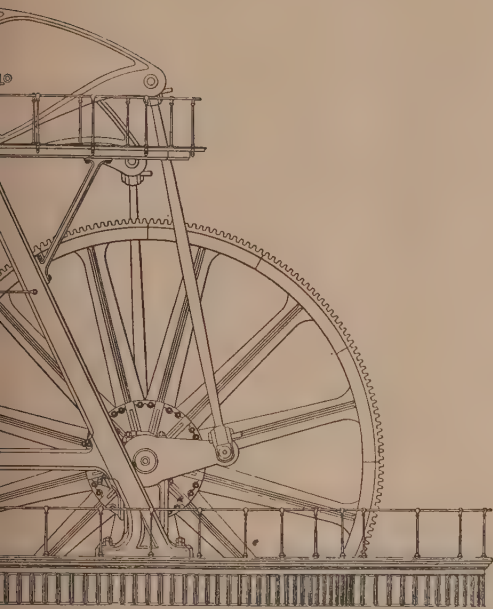


Side Elevation.

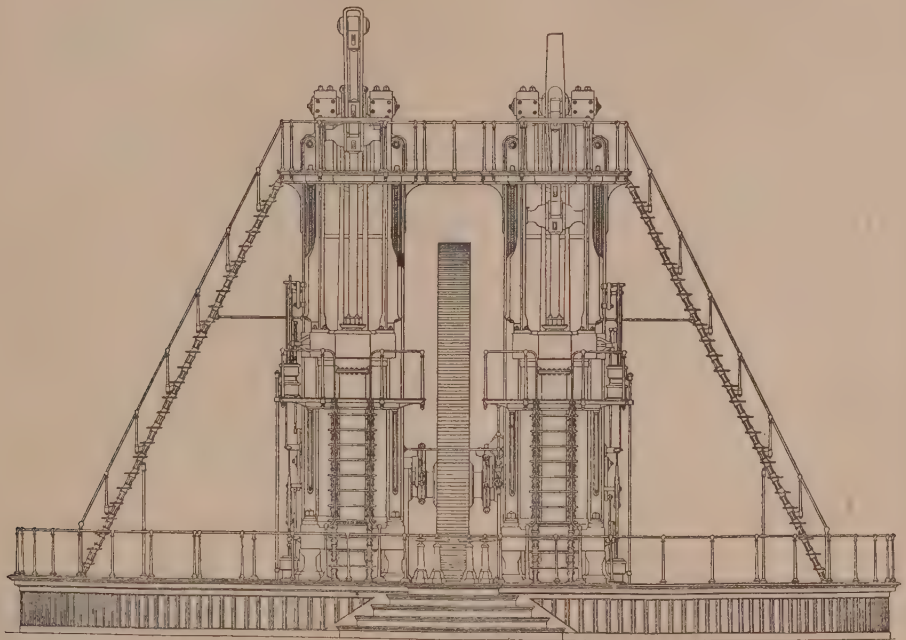


Plan.

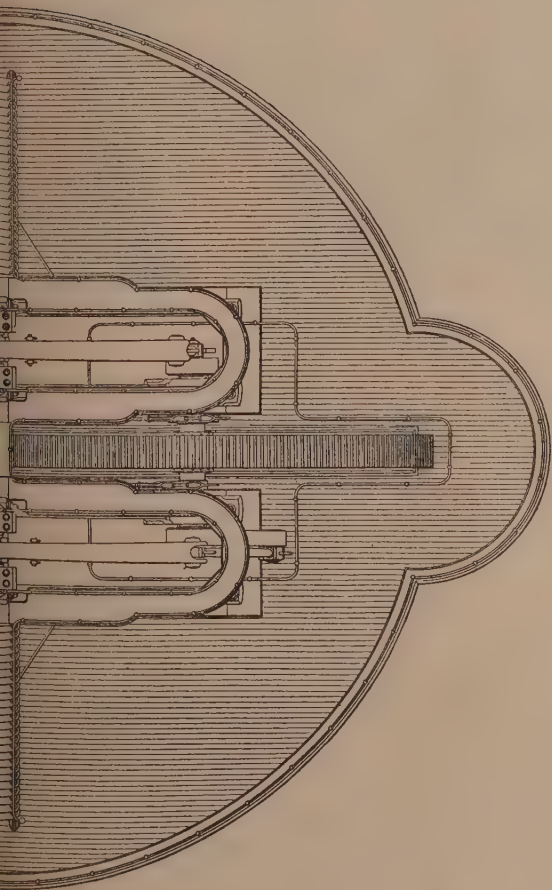
REYNOLDS' QUADRUPLE EXPANSION ENGINE, WORLD'S COLUMBIAN EXPOSITION.



ion.



End Elevation.



ian.

NE, CENTENNIAL EXHIBITION.

COMPARATIVE PLANS AND ELEVATIONS
of
2,500 HP. REYNOLDS' QUADRUPLE EXPANSION ENGINE

Exhibited by

The Edward P. Allis Co., Milwaukee, Wis.,

at the

World's Columbian Exposition, Chicago, 1893,

and

1,400 HP. CORLISS BEAM ENGINE,

Exhibited by

George H. Corliss & Co., Providence, R. I.,

at the

Centennial Exhibition, Philadelphia, 1876.

0' 1' 2' 3' 4' 5' 10' 20'

Scale.

last feather which finally made reorganization necessary.

The Pennsylvania and Maryland Steel Companies have presented plans for the rehabilitation of their affairs to their creditors. They propose to issue bonds to the amount of \$5,000,000 to take up their present floating debt, amounting to \$6,325,736. It is stated that the plan has received the approval of a large proportion of the company's creditors.

The extended curtailment of production in many lines of industry has operated to somewhat relieve the markets, in which for some time buyers have had all the advantage, and the resumption of operations by many mills and factories is an encouraging sign. Apparently a restoration of confidence which will draw the hoarded currency out of its hiding places back into the channels of trade is all that is needed to start all branches of business again into active operation, the more active and prosperous because stocks of goods have been sold down to a low point during the past few months and will soon have to be replenished.

A FREIGHT WRECK ON THE BIG FOUR.

The accompanying illustrations are drawn from photographs taken at the scene of the wreck which occurred on the night of Aug. 5, on the Peoria Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Danville, Ill. A brief report of

the cars struck the pier and were crushed one after another until the entire train was reduced to splinters.

The illustrations show well the slight injury to the main span, which stood the shock remarkably, except at the west end, which was demolished by its fall to the ground when knocked off the pier. The center pier, against which the cars were crushed, also suffered little harm. The only injuries noticeable were that one of the top stones was slightly moved and a crack was opened about an inch wide half way down. The east abutment had several yards of masonry knocked off.

The bridge was approached from both sides by a heavy grade. There was a tangent about 300 ft. long on the west approach and one about 1,000 ft. long on the east approach. The bridge consisted of 13 bents of trestle on the west end, a 60-ft. span, a 30-ft. tower, a 60-ft. span, the main span, 144 ft., and 9 bents of wooden trestle at the east end. The bridge has been built about 5 years and has always been considered a dangerous point in the road on account of the speed at which it has been necessary to cross the bridge with heavy trains in order to be able to climb the grade on the opposite side.

A large force of men was at once set at work clearing away the wreck. They built a track, leaving the main line 100 yds. west of the bridge, and coming down the hill on a curve to attack the pile of wreckage with a derrick from the north side of the middle pier. In letting the derrick car and locomotive down the hill at 10 p. m., Aug. 6, they ran away and crashed into the pile of wreckage, knocking the trucks from under the derrick car and throwing the locomotive from the track. This delayed the work considerably.

WORLD'S COLUMBIAN EXPOSITION.—XX. Notes of Miscellaneous Exhibits.

Water-Works of Sydney, N. S. W.—Some handsome enlargements of photographs of works of the water supply system of Sydney, New South Wales, are exhibited in the Machinery Building. The works illustrated include a stone-lined canal 9 ft. deep, discharging 150,000,000 gallons daily into a storage reservoir; and a masonry weir across a river. There are also two aqueducts, one of wrought iron 7 ft. 6 ins. diameter with spans of 60 ft., carried on masonry piers, crossing Ouedale Creek; the other consisting of 20-in. wrought iron pipe suspended by steel cables in two spans of 225 ft.

Intercontinental Railway.—A large relief map of Central and South America, showing the route of the projected intercontinental railway and the existing lines which may form a part of the route, is exhibited by the Bureau of South American Republics. It shows more clearly than any ordinary map the conditions to be met with. Along the west coast is the narrow unbroken range of the Andes, with an elevated central plateau between two rows of peaks, while east of this range are two great low-lying plateaus, one covered by the Amazon River and its tributaries, and the other extending south of the La Plata River, these two plateaus being separated by hills north of Paraguay. The country east of a line between the mouths of the Amazon and La Plata rivers is rugged and mountainous, but without the sharp peaks seen on the western range. The map has a horizontal scale of



View Looking West, Cars Wrecked Against Pier.



Wreck of the Main Span at East End of Bridge.

BRIDGE AT DANVILLE, ILL., ON C., C., C. & ST. L. RY. WRECKED BY REAR COLLISION OF FREIGHT TRAINS, AUG. 5.

the accident was given in our issue of Aug. 10. A fuller report is furnished us by a correspondent, as follows:

According to the trainmen's report, "Train No. 44, an eastbound freight, crossed the bridge, became uncoupled and 14 loaded cars ran back down the grade on the east approach to the bridge and collided with train No. 42, which came down the grade at the west approach to the bridge at a high rate of speed to enable it to climb the hill east of the bridge." That is a very good story, as far as the company and the trainmen are concerned; but the fact that train No. 44 was considerably ahead of train No. 42 and that the conductor and trainmen were not on No. 44 when the wreck occurred, leads one to believe that if the train broke in two and ran back on the bridge, the brakes were set and the trainmen were engaged in putting in or repairing the drawbar while they neglected to go back to flag train No. 42.

It is more probable, however, that the rear portion of train No. 44 was left standing on the grade just west of the Danville station while the locomotive was used to switch some cars. The detached portion of the train, being struck by some cars which were kicked back with more than necessary force, was started back down the grade to the bridge, on which it was carelessly allowed to stand until struck by train No. 42. The concussion, together with the friction of the set brakes, moved the main span to the east and let the west end down into the river, letting the small span down at the same time. This span swung back and hung suspended from the top of the tower, while

but the wreck was finally cleared away and a temporary trestle put in place, allowing the first train to cross at 5:50 p. m. on Aug. 11.

The company has had a series of wrecks recently, this one being no less than the fifth within ten days. It leaves a suspicion that they are running their trains short of men, as in this case nothing was said, seen or heard of the rear or middle brakeman of train 42 for three or four days after the wreck, when the statement was made that they had jumped from the train before reaching the bridge, escaping serious injury and had been sent to their homes at the west end of the road. While the doubt as to the above statement exists in the mind, one naturally asks the question whether train 44 was not also short of men, accounting for the failure to send a man back to flag train 42. At any rate, though the wreck may have been inevitable, owing to the impossibility of stopping the train on the grade west of the bridge without air brakes or a large force of brakemen, it would at least have given the trainmen a chance to have reduced the speed and saved themselves by jumping before the train reached the bridge, had a flag been sent back from No. 44.

Another dangerous point on the road known as "Possum Trot" exists a few miles west of this city, at the crossing of the middle fork of the Vermilion River, and the company is at present engaged in changing the alignment of the road for a few miles, putting in a viaduct 1,300 ft. long, and making heavy cuts and fills. The improvement will cost many thousands of dollars, but will almost surely avoid a repetition of the North Fork wreck at that point.

1 in. to 25 miles, and a vertical scale 20 times the horizontal. It was made by E. E. Court, C. E., under the direction of Lieut.-Comm. R. M. G. Brown, U. S. N., and W. D. Kelley, C. E., of the Intercolonial Railway Commission.

Aerating Pump.—A combination water lifting and aerating hand pump for use with water cisterns is exhibited by the Sandwich Enterprise Co., of Sandwich, Ill. It is an ordinary small hand lever pump, with a pipe reaching well down into the cistern. The operation of the pump is controlled by reversing the position of the valve by means of a small lever at the base of the pump stand and a ball on the top of the piston rod. With these in one position water is raised and delivered through a spout in the ordinary way. In the other position air is sucked in by the pump and discharged at the bottom of the pipe, agitating and aerating the water. The end of the pipe is far enough above the bottom of the cistern to prevent stirring up any sediment. The pump has brass valve seats, cylinder lining and piston valve. It is anti-freezing, as a few strokes with valve reversed after pumping water in cold weather will expel all water from the cylinder and pipe. It is strongly made to stand rough usage and may be placed in any convenient location, the base being fitted with a brass union sleeve for lead pipe, and threaded for 1¼ in. iron pipe. The price of the pump is \$10.

Multi-Color Copying Process for Drawings.—Specimens of work done by a process for copying engineering and architectural drawings in colors are exhibited by Warren Ewen, Jr., & Co., of Chicago. The drawings must first be inked in with the special violet, red or green inks (according to the significance of the lines) and washes of color to represent stone, brick and other material are applied by brush in the usual way. Violet is the color generally used for line work which on ordinary drawings would be black. From one such drawing 40 copies can be made, each showing the same colors as in the original, and the reproduction being executed independently of the weather the work can be carried on rapidly. The process is economical in saving tracing cloth and recoloring by hand, while the originals are uninjured and may be recopied at any time. Alterations and additions can be made, and the copies are waterproof. The originals may be on paper, tracing cloth or manila paper, and copies can be taken on white or manila paper or cloth. All the drawings for the World's Columbian Exposition have been copied by the company (which is the exclusive owner of the process), requiring 110 miles of paper 3 ft. and 4 ft. wide. A testimonial from Mr. E. R. Graham, Assistant Chief of Construction of the Exposition, says that the results obtained from tracings and paper drawings of 33 copies each have also been tirely satisfactory. The process has also been employed for three years by Burnham & Root, architects, Chicago, and by a number of other leading architects in Chicago and other cities.

Rust Proofing for Iron.—A German method of rust proofing iron by a cold process is shown by E. Joki and Sigmund Raudnitz, of Vienna, Austria, and it is claimed to be superior to the Bower-Barff and Gessner processes, both of which require the iron to be heated. The invention produces the chemical change upon the surface of the iron by laying the iron for some time in a cold solution of different salts (the composition of which is apparently a trade secret), and then drying it in the open air or in evaporating chambers. The cost of plant and treatment is said to be very moderate. It is proposed to apply the process to gas and water pipe, telegraph and electric railway poles, metal ties, railings, pumps, etc., and to conduits for electric wires, since the process gives a non-conducting lining. Experiments made at the laboratory of the Royal Museum for Technical Trades at Vienna, with tubes in solutions of various acids, have given satisfactory results.

THE USE OF CONCRETE IN RAILWAY STRUCTURES

Concrete is becoming a more and more generally used material in engineering construction, and we reprint below an interesting article on its use from London "Engineering":

Concrete as a material for engineering works has, until within comparatively recent years, been chiefly confined to harbor works; but lately it has been used in the construction of railway works, both at home and abroad. The advantage of employing this material is apparent in districts where the absence of good building stone or clay for the manufacture of bricks makes the cost of masonry or brick structures very great. One of the early applications of concrete for railway works was in connection with the last section of the Callander & Oban line, from Dalnally to Oban, in the west of Scotland. In this case the material was largely used in the form of rubble concrete for bridges, arches, culverts, retaining walls, platform walls, turntable and engine pits. Since the completion of that railway, Mr. John Strain, the engineer, has carried out the same methods of construction on a number of lines in Scotland and also in Spain.

Rubble concrete consists of large stones embedded in a matrix of Portland cement concrete. The Portland cement used in these works was very carefully specified and tested to secure its being of the very best quality. In every case it was required to be stored at the works at least one month before being used, being placed under cover in perfectly dry sheds erected for the purpose. During the fortnight prior to its use it had to be spread out on a wooden floor raised 2 ft. above the ground, and turned over every alternate day during the fortnight, or until it was sufficiently cooled and fit for use. The cement had to satisfy the following conditions: The residue on a sieve of 2,500 meshes per sq. in. was not to exceed 20%; weight per cu. ft. to be not less than 90 lbs.; test bricks of neat cement and of cross section $1\frac{1}{4}$ ins. square, to stand a tensile strain

of 790 lbs. when seven days old, during the last six of which they were immersed in water. After the cement was sufficiently turned it was refilled into bags, the contents of each bag bearing a direct ratio to the size of the gateboxes used for the ballast. The sand used was always of coarse, sharp quality and perfectly clean, being washed in every case where it was necessary to do so. The usual mixture for the concrete on these works was as follows: One part by measure of cement to five parts by measure of clean ballast. The ballast consisted of clean broken stones or slag and coarse-grained sand—the stones or slag were angular and of hard quality, broken to pass through a screen 2 ins. wide in the meshes—the proportion of sand to the stones being determined by experiment from time to time. The whole materials, after being carefully measured, were thoroughly mixed together dry by turning over at least four times, and then further mixed by turning at least four times while a proper quantity of water was added through a rose. The mixing was done on a timber platform in a systematic manner by four men standing in a row, turning over the material by shovels from one to the other.

The method of employing materials in the construction of what is termed rubble concrete was as follows: A bed of concrete, at least 6 ins. thick, was put in before each course of stones, and on this layer of concrete rubble stones were laid, care being taken that no two stones were nearer one another than 3 ins., nor nearer the face boarding of any exposed surface than 3 ins. The stones were firmly bedded down to make a solid bed, and afterward carefully rammed and probed all round with a trowel to leave no interstices. All

smaller in size was placed in position by a steam derrick crane, and thus the construction of the pier was accomplished. The following table gives some of the dimensions of the bridges and the time taken in building:

Name.	Length.	Height of		Quantity of	Time taken to
		of piers.	of spans.	building.	build.
	Yds.	Ft.		Cu. yds.	Weeks
Tamujoso River.	145	28	12	1,737	14½
Oraque.	141	31	11	1,590	15
Cascabelero.	160	30 to 80	10	2,680	21
No. 16 (Valley).	98	28 to 50	7	1,046	16½
Tiesa.	55	16 to 23	8	420	4

It is quite evident from these figures that the question of time is an important element in this form of construction. The construction of some of these bridges in ordinary masonry would probably have taken nearly as many months as the number of weeks occupied. The system adopted also enabled the work to be carried out largely by unskilled labor, with great rapidity and economy. The rock available for rubble stones in these piers was not of such a class as to give large blocks, consequently the proportion of pure concrete to the total mass of rubble concrete was larger than would have been the case had larger blocks been got. The average proportion of pure concrete in the piers was 69.7%, and in one case where the stones were smaller than usual the percentage was as high as 76.5%. In other work the proportion has been as low as about 40%. In rubble concrete faced with squared rubble, and about 55% in rubble concrete faced with fine concrete.

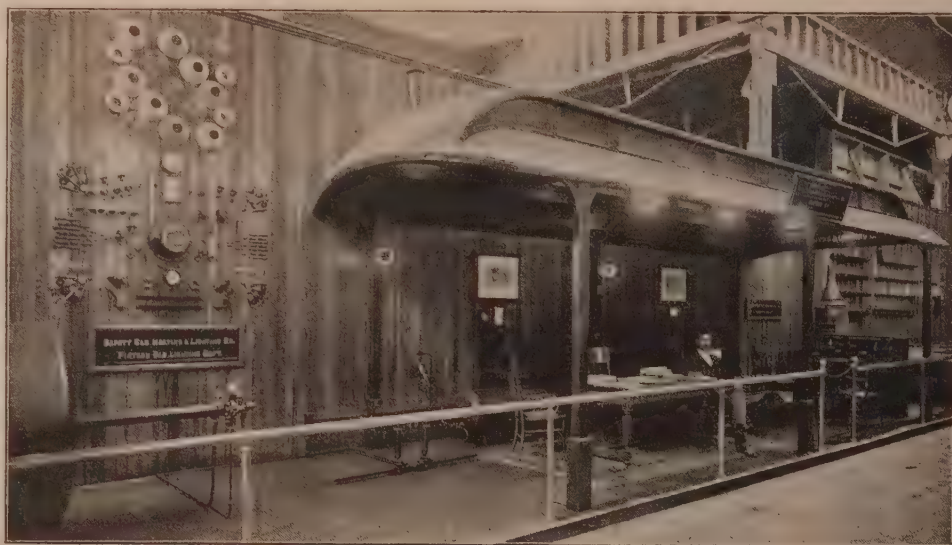


FIG. 1. THE PINTSCH GAS EXHIBIT AT THE COLUMBIAN EXPOSITION.

stones were placed irregularly, with their diagonals at right angles to the exposed surfaces. Over each layer of rubble stones a further layer of concrete was placed and leveled off at a height of 6 ins. above the top of the stones, and on this again a further course of rubble stones was placed and beaten down as before. All the faces were carefully formed against close horizontal boarding made into frames or boxes the shape of the work, and the concrete against these boards was carefully worked with trowels so as to leave the face quite smooth without any rendering or dressing. At exposed corners wood was placed to form chamfers. This rubble concrete has been largely used for ordinary abutments and wing walls of girder bridges of different spans. It has been extensively used for the intermediate piers of long viaducts and also for arches.

The best examples of its application to piers are to be found in the viaducts over the principal valleys and rivers crossed by the Tharsis & Calanias Ry., in Spain. These viaducts were constructed in spans varying from 40 ft. to 45 ft., with piers which vary in height up to 80 ft. All the piers were made of standard dimensions at the top—13 x 50 ft.—and with the same batter, 1 in 30, to enable the molds or frames of one pier to be used for all. Piers exceeding 33 ft. in height were at that distance from the top battered out an additional 1.6 ft. at each side in a height of 1.6 ft., below which the batter of 1 in 30 was continued. The frames or molds were simply large boxes without top or bottom. The four sides could easily be taken apart and put together. The depth of the boxes was uniform, and they were numbered consecutively from top downward. Thus the engineer in charge of the works, knowing the height of his pier, could determine the measurements at base, and knew which size of box to use as a mold. As each box was filled, the next one

The average quantities of the various materials required for 1 cu. yd. of building of the average proportions was as follows:

- .304 cu. yd. of rubble stone (measured as solid).
- .684 cu. yd. of broken stones (measured in heap after breaking), representing about—
- .342 cu. yds. of solid stone,
- .358 cu. yds. of sand,
- .178 cu. yd. of cement (448 lbs.).

On the Lanarkshire & Ayrshire Ry., Scotland, this method of construction was very extensively employed. The heaviest bridges in which it was adopted were the bridge carrying the Ardrossan line over the Glasgow & Southwestern Ry., near Stevenston, the bridge carrying the Irvine line over the river Garnock, and the bridge carrying the Kilbride line over the Glasgow & Southwestern Ry. at Glengarnock. The first-named is built on a very heavy skew, 28°, and consists of two spans of 34 ft. and 107 ft. respectively (measured on the angle). The quantity of rubble concrete used was 1,650 cu. yds. It is a through bridge for a double line of railway, the floor consisting of cross girders and troughing carried by two massive lattice girders. The second named bridge, that over the river Garnock, consists of two central spans of 51 ft. and two side spans of 26 ft. 6 ins., and is built on the square. The pier in the middle of the river was built within a cofferdam and carried down to a depth of about 10 ft. below the river bottom. The quantity of rubble concrete used was 1,400 cu. yds. The superstructure consists of plate girders, and the bridge is decked with buckle plates covered with a layer of about 4 ins. of concrete. The ballasting is carried through, but on the bridge it consists of ashes, instead of the broken slag used generally on the whole line.

In the third bridge named, that carrying the Kilbride branch over the Glasgow & Southwestern Ry. at

Glengarnock, the two abutments were built entirely of rubble concrete, of which about 2,300 cu. yds. were used. The superstructure consists of cross girders and buckle plates carried on the top chord of two heavy lattice girders.

In building these bridges the manipulation of the materials was done in steam concrete mixers, which enabled a rate of building of 25 to 40 cu. yds. per day to be attained. The rubble concrete was built within frames of horizontal boarding carried by vertical framing. For the bridges on the Ardrossan and Kilbirnie branches, the materials were the same as described in the case of the Tharsis & Calanas line; but on the Irvine line cement of a finer quality than that already described was used, leaving a residue not exceeding

pendicular to the surface of the cleading, the layers themselves being at right angles to the center line of the bridge, so that each layer corresponded roughly to a course of arch stones. As the layers approached the crown of the arch they became more and more nearly vertical, so that some difficulty was experienced in keeping the surfaces perpendicular. Each of the arches was thrown in one day, which was an important point in obtaining thorough homogeneity throughout. The Board of Trade inspector, in order to satisfy himself as to the hardness of the concrete, sent men to drill holes through the arch, and found that the depth drilled was only about one-third of that which could be done in the same time through ordinary building stone.

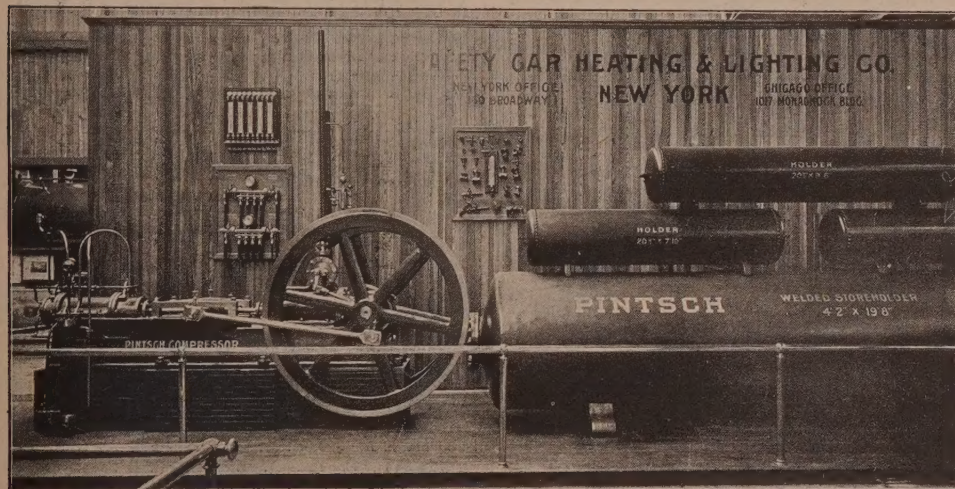


FIG. 2. PINTSCH GAS COMPRESSOR AND STOREHOLDERS.

10% by weight upon a sieve having 5,800 meshes per sq. in., and having a tensile strength of not less than 790 lbs. upon an area of $2\frac{1}{4}$ sq. in. After the concrete had been well mixed, it was tipped inside the boarding, leveled and well worked at the face. Then large, irregular-sized stones up to 2 tons in weight (as they came from the quarry) were set so as to be 3 ins. from the boarding and from one another, and were then firmly beaten down with mallets to make a solid bed. All the spaces round the stones of this course were then packed solid with concrete, which was well worked as before. This course of stone was followed by another course of concrete 6 ins. thick, followed by another course of stone, and so on. Without counting the men engaged in breaking stones close by, the following were the numbers employed per crane: One crane man and boy, one mason and ten laborers. In addition to these, about a quarter of the time of a joiner and his laborer was required daily to raise the boarding by a few feet at a time, so as not to cause unnecessary lifting of the stones. For ordinary bridges of about 400 cubic yards, the daily rate of progress was about 12 to 15 yds., whereas for larger bridges the rate was from 20 to 25 cu. yds. daily. To maintain the same rate of progress in a rubble bridge of similar size would require about twice as many men, of whom a large proportion would be masons. Ten days usually were allowed to elapse before the boarding was removed. Weeping-holes were formed by inserting 2-in. tile drain pipes at intervals, and advantage was taken of these pipes to insert bolts during the construction of the walls for tying together the two sides of the frame. As showing the hardness of the rubble concrete it may be mentioned that in the case of one of the bridges on the Irvine line the abutments slipped forward and it became necessary to chip off a few inches of the face and reface them. Each quarryman employed could only on the average remove $5\frac{1}{2}$ cu. ft. per day.

The arches over the River Dochart, on the Killin Railway, in Scotland, form an excellent example of the application of concrete construction of this type of bridge. This viaduct consists of five arches of 30 ft. span on the square and of 42 ft. measured on the skew, the angle of obliquity being 45° . The piers were built in rubble masonry laid in cement mortar, the arches being thrown in concrete. The piers, spandrels, and a part of the arch were first carried up to about 5 ft. above the springing. The arches were then thrown, each in one day. The concrete, which was of the same composition as that already described, was mixed by hand upon a platform about 300 ft. from the bridge, and was wheeled along a gangway to a point directly above the arch, where it was tipped over upon the centering. It was then carefully rammed in layers about 6 ins. thick, the surface of the layers being kept per-

For smaller works, such as culverts, platform walls, masonry drains, etc., of which many are required of the same pattern on every contract, concrete is eminently suited, as the same molds may be used again and again; it was not deemed necessary to use pure concrete for such works, and rubble concrete made with large, flat stones radiating from the center of the arches was employed.

A great economy is also effected in the dimensions of masonry structures when rubble concrete is used, as

its application to such buildings is found in the engine shed at Ardrossan. The shed is 169 ft. 6 ins. long and 58 ft. 8 ins. wide inside, and accommodates 12 engines, there being four lines of rails. The side and end walls are constructed in bays of about 15 ft., between vertical rolled columns, and are entirely of concrete made up of one part Portland cement to five parts of ballast. The method adopted was to lead both sides of the space (15 ft.) between the columns with horizontal planks, put up one by one as the concrete was brought up, and then to fill in the space between the planks with concrete, which was carefully worked against the planks on both sides to give a smooth surface. The concrete was brought up in layers of about 18 ins. in depth. The walls are 10 ins. thick, and flush inside and outside with the columns. The rails are laid on longitudinal timbers 15 ins. broad by 5 ins. thick, and the cleaning pit runs the whole length of the shed under each line of rails, being 3 ft. 8 ins. wide and 3 ft. deep below rail level. All the spaces between the lines of rails were covered with concrete 5 ins. thick, draining into the cleaning pits. There are three hydrants between each pair of lines of rails for supplying water for cleaning purposes. The height of the roof to the underside of the beams is 16 ft. above rail level, and smoke traps are formed for each line of rails down to 12 ft. 3 ins. above rail level. The smoke is carried off by chimneys in each bay of the roof. The shed is entirely lighted from the roof, and is supplied with fittings for lighting with gas. The cost, with an adjoining range of buildings, consisting of offices, foremen's room, store, bothy, smithy and sand-drying kiln, was \$11,750. There is a 50-ft. turntable in connection with the shed.

THE WORLD'S FAIR EXHIBIT OF THE SAFETY CAR HEATING & LIGHTING CO.

The exhibits of the car heating and car lighting companies at the Columbian Exposition are located in the annex just south of the British exhibit, opposite that handsome old locomotive of the Great Western Ry., "Lord of the Isles." Our illustrations herewith are reproduced from photographs of various parts of the exhibit of the Safety Car Heating & Lighting Co. The company has erected a car roof over part of the space, and the latest pattern of Pintsch gas lamps are shown in place, exactly as when in use on a car.

Of the generating station equipment, the company shows one of the large storeholders with welded seams and a standard gas compressor. The

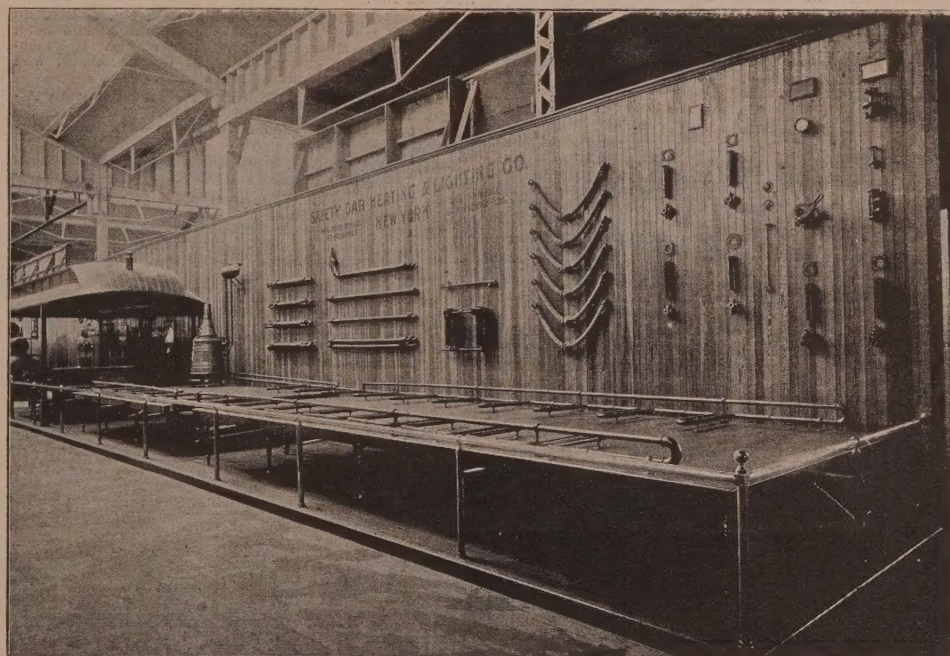


FIG. 3. STEAM CAR HEATING EXHIBIT OF THE SAFETY CAR HEATING & LIGHTING CO.

the volume may be reduced to 70% of that required with ordinary masonry built in lime mortar, while at the same time the concrete gives greater strength. In order to compare the relative costs of material fairly, it is necessary under these circumstances to deduct 25% from the cost of the rubble concrete per yard.

Concrete is also very suitable for the construction of engine and goods sheds and similar buildings in connection with railway works. A good example of

storeholder, which is an interesting example of difficult welding, was made at the works of Julius Pintsch, at Berlin. It is surmounted by several car reservoirs of different sizes.

The gas to supply the plant is piped from the Pintsch gas station at Chicago, is stored in the holder, and passes through the usual pressure reducer for use in the lamps as required. The company states that over 55,000 cars are now

equipped with the Pintsch gas system of lighting, including cars in nearly all the countries of continental Europe, and in England, India, South America and the United States.

Part of the space occupied by the company is devoted to an exhibit of the company's steam car heating systems. The hot water system is shown in connection with the Baker heater, which can be used in case the car is side-tracked or steam from the locomotive is cut off for any reason. This system is in use on over 2,000 cars; the direct steam system, arranged so that the radiating surface can be adjusted to correspond to the weather, is also exhibited. This system was described in our issue of Nov. 22, 1890.

CONSTRUCTION NEWS

RAILWAYS.

East of Chicago—Existing Roads.

ALPENA & NORTHERN.—Tracklaying on this railway between Alpena and Hillman, Mich., was commenced Aug. 9.

CANADIAN PACIFIC.—It is reported that a large force will be put at work this winter on the extension of the Lake Temiscamingue Colonization Ry. to the head of the lake. The work is to be completed by June 10, 1896.

PENNSYLVANIA.—Plans have been submitted to the city of Chicago by this company for the elevation of its tracks from Archer Ave. to Englewood, the work to be completed within three years, at an estimated cost of nearly \$2,000,000.

Projects and Surveys.

INDIANA.—A press dispatch from La Porte, Ind., states that a company of Chicago and New York capitalists is being organized by Lieut.-Gov. Mortimer Nye to build a railway from that city to Chicago through Westville and Valparaiso.

MICHIGAN.—Surveys are being made for a railway from Benton Harbor to Kalamazoo. It is rumored that the scheme is backed by the Grand Rapids & Indiana.

PETERSBURG & SEA ISLE.—Incorporated in New Jersey to construct and operate a railway in the townships of Upper and Dennis, Cape May Co.; capital stock, \$154,000; L. M. Bullitt, Thomas Robb, C. S. Thore, O. L. Kensil, T. H. Wilson, Philadelphia; J. C. Taylor, V. M. DeMarcy, James McCray, James K. Evans, Jr., Cape May, N. J.

RESTIGOUCHE & VICTORIA.—At a meeting of the stockholders of this company at Cambeltown, N. S., Aug. 10, it was resolved to take immediate steps to secure the survey of the first 15 miles of the projected road.

Southern.—Existing Roads.

CHATTANOOGA WESTERN.—This company has completed the purchase of the Chattanooga Terminal Ry., for which negotiations have been under way since the county granted it the right to construct a bridge across the river at Chattanooga, Tenn. The terminal company has valuable terminal facilities, but its tracks have not been used for some time.

WEST VIRGINIA & PITTSBURG.—Surveys are about completed for a railway 17 miles long to be built in West Virginia by the Holly River Lumber Co. It is reported that the construction will soon be commenced.

Projects and Surveys.

COAL RIVER & ST. ALBANS.—Incorporated in West Virginia to build a railway from St. Albans, on the Chesapeake & Ohio, and the Kanawha River, in Kanawha Co., W. Va., along Coal River into Boone Co.; capital stock, \$250,000; incorporators, M. P. O'Hearn, W. S. Laidly, J. H. Hunt, A. Burlew and J. B. C. Drew, Charleston, W. Va. The company has purchased the property of the St. Albans R. R. Co. consisting of embankments, culverts, real estate, etc., for \$236,000, payable in unassessable shares of capital stock.

Northwest—Existing Roads.

CANADIAN PACIFIC.—The extension from Pasqua to the international boundary line is expected to be opened for traffic early next month. The tracklayers reached the boundary line at Sterling Aug. 12, and surveyors are now laying out a town at that place. The tracklayers of the Minneapolis, St. Paul & Sault Ste. Marie are 25 miles distant, and expected to reach Sterling this week.

GREAT NORTHERN.—It is reported that the contractors who are rebuilding the road between Mayville and Casselton, N. Dak., expect to have the grading completed this month.

Projects and Surveys.

CANADA.—The "Official Gazette," Ottawa, Ont., states that application will be made at the next session of the Dominion Parliament for the incorporation of a company to build a railway from Regina, Northwest Territory, southerly to the boundary near Wood Mountain; also from Regina northeasterly to the Saskatchewan River.

Southwest.—Existing Roads.

LA PORTE, HOUSTON & NORTHERN.—The charter of this company has been amended so as to provide for branches from La Porte, Tex., through Harris and intervening counties to a point on the Sabine River in Newton Co. at or near the mouth of Anasosa River and from La Porte to Galveston.

TEXAS CENTRAL.—Chas. Hamilton, Gen. Man., Waco, Tex., is reported as stating that work on the proposed extension of this road to Thurber, Tex., will be commenced this month. The new line will furnish an outlet to market for the Texas & Pacific Coal Co.'s mines near Thurber.

Projects and Surveys.

RIO GRANDE NORTHERN.—G. N. Marshall, Ch. Engr., El Paso, Tex., informs us that the projected length of this road is 35 miles, of which 26 miles have been surveyed and the line located to Chispa, Tex.

The grade is 1.6% and the curvature 8 to 10°. The road is projected to develop the San Carlos coalfields, and the right of way has been secured.

Rocky Mt. and Pacific—Existing Roads.

DENVER & RIO GRANDE.—A spur two miles in length will soon be built near Williamsburg, Colo., from the Oak Creek branch to the United Coal Co.'s new mines.

ELK MOUNTAIN.—Reports from Pueblo, Colo., state that the laying of steel rails on this road from Sand Creek up Rock Creek will be commenced this week. The line extends from Carbondale to Marble, Colo., a distance of 32 miles.

EVERETT & MONTE CRISTO.—The tracklaying has been completed into Monte Cristo, Wash., and the work of surfacing and ballasting is progressing rapidly. The road will be in operation next month. A cut-off is being considered between Everett and Hartford, a distance of six or seven miles.

STREET RAILWAYS.

HOLBROOK, MASS.—T. A. Hobart has been elected president, and George A. Beatey treasurer of the proposed belt electric railway company.

NEW BEDFORD, MASS.—The council has granted the different companies permission to make extensions and to adopt the trolley system of motive power, and it is expected that the work will soon be commenced.

GENEVA, N. Y.—The Geneva & Waterloo Ry. Co. will receive bids until Sept. 1 for the construction of an electric railway.

BAYONNE, N. J.—A franchise for an electric street railway has been granted to the Jersey City & Bergen Ry. Co. Through cars are to be run from the Kill Von Kull to Jersey City ferry for a five-cent fare, and a line constructed also to Constable Hook.

PASSAIC, N. J.—The Gray Electrical Transit Co. has been incorporated to operate in this city and New York; capital stock, \$75,000.

JEANESVILLE, PA.—The material for the extension of the electric railway from this town to Audenried is being distributed along the line, and the work of tracklaying will soon be commenced.

PITTSBURG, PA.—The Citizens' Incline Plane Co., referred to in our issue of Aug. 3, has been incorporated by J. A. McCormick, Peter Sullivan, J. A. Langdon and others; capital stock, \$5,000.

TOWSON, MD.—Maj. Charles B. McClean, Co. Surv., has been appointed engineer of the Baltimore, Middle River & Sparrow's Point R. R., noted in our issue of Aug. 3.

GRAHAM, VA.—Surveys are being made for an electric railway from this place to Bluefield, W. Va., a distance of three miles.

YOUNGSTOWN, O.—The Youngstown Park & Falls Electric Railway Co. has been incorporated by George A. Baker, J. H. McEwen, and others, to build an electric railway to Lauterman's Falls; capital stock, \$65,000.

ELWOOD, IND.—The Elwood Electric St. Ry. Co. is contemplating an important extension, including a line to Alexandria by way of Orestes, a distance of ten miles.

MILWAUKEE, WIS.—The Milwaukee & Wauwatosa Motor Co. has voted to change its motive power from steam to electricity. It is probable that the Greenfield extension will use the trolley system and be in operation this fall.

ATCHISON, KAN.—The Atchison St. Ry. & Electric Light Co., noted Aug. 10 as incorporated, has been granted a franchise, and it is reported that the electric railway will be in operation by December, and five miles of track laid within a year.

SOUTH OMAHA, NEB.—The street railway to Albright which has been run by mule power for the last two years, will soon be equipped with the trolley system, according to reports.

SALT LAKE CITY, UTAH.—A franchise has been granted to Otto Stallman and Stephen A. Estes.

PORTLAND, ORE.—The Portland & Hillsboro R. R. Co. has been organized to build an electric railway between Portland and Hillsboro to carry passengers and freight. It is expected that the road will be built next summer. Pres., R. W. Baxter; Vice-Pres., B. Campbell; Secy., W. W. Cotton.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The Metropolitan Elevated R. R. has now acquired the right of way from Jefferson St. west to the city limits, and it is expected that the right of way will soon be completed from the city limits to the river. Negotiations are in progress for the right of way east of the river as far as Fifth Ave., where the terminal station will be located. It is stated that owing to the financial stringency the company has made settlements for property on a much more favorable basis than was anticipated, as it had several million dollars in hand at the beginning of the trouble, and was in a position to take advantage of the situation. Permits for 11 stations have thus far been applied for.

HIGHWAYS.

OHIO.—The commissioners of Hamilton county will receive bids until Sept. 9 for the improvement of Fairview and Boice Aves., in Columbia township. John Hagerty, Co. Aud., Cincinnati. Bids are asked until Sept. 15 for \$25,000 of West Fifth Ave. improvement bonds, interest payable semi-annually at 6%. Henry J. Caren, Aud. Franklin Co., Columbus.

INDIANA.—The gravel road election in Brazil, Dick Johnson and Van Buren townships resulted in a majority of about 1,000 votes in favor of the construction of the roads. There were two gravel and two macadamized roads voted upon, the total length being about 20 miles; estimated cost, \$80,000.

BRIDGES.

PHILADELPHIA, PA.—Plans have been prepared for a double-decked steel bridge, 1,131 ft. long and 70 ft. wide, to replace the one at the Falls of Schuylkill, recently blown down; estimated cost, \$700,000.

MILWAUKEE, WIS.—The Milwaukee Bridge & Iron Co. has been awarded the contract for the construction of the folding draw for the Holton St. viaduct. Its plan was drawn by Shaller & Schinaglan, Chicago, and the gearing will be similar to the Canal

St. bridge in that city. The cost of the draw will be \$40,000 and \$2,500 extra for the electric motor.

WACO, TEX.—W. H. Jenkins, Co. Judge, and members of the county commissioner's court are preparing a proposal to be submitted to the city council for the construction of a bridge in this city to cost about \$50,000.

BRIDGES BURNED.—A bridge 48 ft. long, on the Illinois Central R. R., near Flanagan, Ill., was burned Aug. 7. A bridge on the Canadian Pacific Ry., one or two miles west of Portage la Prairie, was burned Aug. 14. Two bridges on the Great Northern Ry. were burned Aug. 12; one near Odessa, some 25 miles west of Spokane, and the other on the Kallispell division.

WATER-WORKS.

AUBURN, ME.—The council has appropriated \$25,000 for improvements and extensions.

CHARLESTOWN, N. H.—A town meeting was called for Aug. 24, to consider the question of works for fire protection.

WEST RUTLAND, VT.—It is reported that works will soon be put in.

MERRIMAC, MASS.—A reservoir is to be built on Vendome St. for fire purposes, according to reports.

NEWBURYPORT, MASS.—An election will be held Aug. 31 to vote on the question of purchasing the works.

NORTH ANDOVER, MASS.—A special meeting will be held Aug. 30 to vote on the question of a supply.

TUCKAHOE, N. Y.—The council has ordered an issue of \$50,000 of water bonds.

JERSEY CITY, N. J.—W. E. Reed, Pres. Richmond & Chesapeake R. R., has made a proposition to supply the city with water, by gravity from Boonton, according to reports.

ALLENTOWN, PA.—The council has passed an ordinance appropriating \$1,200 to employ an engineer to examine the present works and plans for proposed additional supply.

BANGOR, PA.—It is reported that an election will soon be held to vote on the issue of bonds for works.

BENNETT, PA.—The contract for works has been awarded to Chanley Bros. & Co., Beaver Falls, at \$63,500.

BLAIRSVILLE, PA.—The citizens have voted to issue bonds for \$20,000 for improvements.

POTTSVILLE, PA.—A. B. Cochran & Son, Engrs., have prepared plans for rebuilding the Kaufman dam.

RENEVO, PA.—Jas. P. Roach, Agt. for the Gatzmire property at Drury's Run, will build a reservoir and lay 4,000 ft. 3-in. main to secure a supply for tenants, according to reports.

WINCHESTER, VA.—Bids are asked for pumping machinery, it is reported; also for a stand-pipe and 12-in. pipe. C. E. Hoover.

GRAFTON, W. VA.—An election was held Aug. 21 to vote on an issue of bonds for works.

PIEDMONT, W. VA.—The contract for works has been awarded to L. G. Hallock, Wheeling, W. Va., at \$36,100. Detailed prices will be published later. Alexander Potter, Engr., New York.

AUGUSTA, GA.—A committee has been appointed to secure a better supply.

GAINESVILLE, FLA.—Boulware springs, about two miles distant, have been purchased for a supply.

JACKSONVILLE, ALA.—New works will be constructed, according to reports.

NATCHEZ, MISS.—It is reported that the Natchez Water & Sewer Co. will issue bonds for extensions.

ATHENS, O.—C. E. Koon & Co., Upper Sandusky, have submitted a proposition to construct works for a rental of \$3,000 per year.

CELINA, O.—An election will be held Aug. 28 to vote on the question.

CINCINNATI, O.—The contract for a pump at Eden Park has been awarded to the Wilson-Snyder Mfg. Co., at \$9,150, according to reports. The bids were published last week.

DAYTON, O.—The contract for a stand-pipe at the asylum for insane has been awarded to the Miami Valley Boiler Works, Dayton, at \$2,360, and that for stand-pipe pier to Nolan & Hiller, Dayton, at \$5,837. John W. Hill, Consult. Engr., Cincinnati.

ELMWOOD, O.—The council of Carthage has offered to furnish a supply at 3 cts. per 1,000 gallons and it is thought it will not cost over \$5,000 to lay the necessary mains.

CHICAGO, ILL.—The Mount Clemens Water Co. has been incorporated by Chas. T. Davis, W. A. Vincent and Hamilton Anderson; capital stock, \$100,000.

GALESBURG, ILL.—Bids are asked until Aug. 28 for a storage reservoir, as stated in our advertising columns, J. C. Stevens, Cy. Clk.

MILWAUKEE, WIS.—The committee has recommended the purchase of 1,500 tons of pipe and extensions in 13 streets.

WINONA, MINN.—Separate bids will be received until Aug. 28 for furnishing and laying 2,200 lin. ft. 8-in. pipe. O. H. Clarke, recorder.

CALDWELL, KAN.—The works will be sold at sheriff's sale on Sept. 1. They are appraised at \$17,050.

SHERIDAN, WYO.—Bids are asked until Sept. 4 for \$75,000 of water bonds. We are informed by B. F. Perkins, Tn. Clk., that a gravity supply is proposed from a creek 10 miles distant.

MINERAL WELLS, TEX.—The Mineral Wells Artesian Water Co. has been organized; capital stock, \$10,000; Pres., L. B. Kidwell; Treas., Ed. C. Baker.

PORTLAND, ORE.—The lowest bids for reservoirs were as follows: T. N. Aldrich, Portland, high-pressure reservoir at City Park, \$26,900; J. R. O'Neil, Portland, high-pressure reservoir at Mount Tabor, \$8,340, and low-service reservoir in the Grover tract, \$14,550. The bids for laying submerged pipe across the river were as follows: Huber & Smith, cast iron, \$84,900; Bullen Bridge Co. welded steel, \$68,000; Philip Gerber, cast iron, \$102,900; Hoffman & Bates, cast iron, \$73,800; R. Wakenfeld, riveted steel, \$70,000; Risdon

Iron Works, \$109,000; Willamette Iron Works submitted bids on several specifications, No. 1 being \$68,400. No contracts will be awarded until Sept. 7.

LOS ANGELES, CAL.—The committee has unanimously recommended that negotiations be commenced for the purchase or construction of works, in order to secure a better supply.

GRANBY, QUE.—A franchise has been granted to C. H. Payton.

AYLMER, ONT.—The council is considering a proposition from Perry & Co. for works.

KINGSVILLE, ONT.—It is reported that works will be put in.

ARTESIAN WELLS.

GLENDAL, O.—Bids are asked until Sept. 1 for sinking an 8-in. well. Specifications on file with Chas. B. Going, Secy., United Bank Bldg., Cincinnati.

IRRIGATION.

DENVER, COLO.—The state canal board has voted to re-advertise the work of constructing state canal No. 1, the contract for which it had previously decided to award to D. G. Kirshbaum & Co., Denver, at \$1,023,000. It is stated that the canal will be 86 miles long and will reclaim about 300,000 acres of land.

ESTES PARK, COLO.—A charter has been obtained by an English company, according to reports, for the purpose of constructing a masonry dam and making a storage reservoir of Willow Park; estimated cost, \$1,000,000.

SEWERS.

PORTLAND, ME.—Geo. N. Fernald, Cy. Engr., informs us that the contract for 1,015 ft. of 60 x 75 ft. masonry sewer has been awarded to Thos. Shannahan, at \$4,677. The city will furnish all materials, except stone for rubble masonry. All material delivered near line of work by city except broken stone for concrete and sand, which the contractor will haul about 500 ft. The prices, including cement and brick, will be published later.

LACONTA, N. H.—The council has voted to advertise for bids for sewers in wards 2, 3 and 6.

BOSTON, MASS.—The lowest bid for section 44½ of the metropolitan main sewer, in Winchester, was that of Weaving, Booth & Co., Dorchester, at \$31,047. The prices will be published later.

LENEX, MASS.—At a town meeting Aug. 16 a proposition was adopted for the location of a sewage pumping station, and the selectmen were instructed to raise \$25,000 for the proposed extensions.

NORTH BROOKFIELD, MASS.—Bids will be received about Sept. 1 for 2,550 lin. ft. 12-in. Akron pipe sewer, extension to present system, and 1,600 lin. ft. 10-in. cast iron invert, maximum depth 23 ft., to force sewage upon irrigation field of 17 acres on town farm. Geo. A. Craig & Son, Engrs., Spencer.

PLYMOUTH, MASS.—Bids are asked until Aug. 30 for 7,750 lin. ft. 24 to 8-in. vitrified pipe sewers and about 1,300 lin. ft. 14-in. cast iron submerged outlet. Jas. B. Collinswood, Secy. Com. Chas. F. Chase, Engr., Providence.

HARTFORD, CONN.—The city has authorized the construction of the proposed trunk sewer to take the sewage out of the Park River.

WALLINGFORD, CONN.—An election has been held to vote on an appropriation of \$9,000 for sewers.

GENEVA, N. Y.—The state board of health has refused to approve the plans for the proposed system which provided for emptying the sewage into Seneca Lake. D. B. Backenstoes, Chn. Com.

NEW YORK, N. Y.—The report of the commissioner of street improvements in wards 23 and 24 shows that work is under contract for sewers, street regulating and grading estimated to cost \$2,173,549.

UTICA, N. Y.—Bids will be received until Sept. 1 for a trunk sewer estimated to cost \$53,000, as stated in our advertising columns. C. W. Adams, Cy. Surv.

ENGLEWOOD, N. J.—The Englewood Sewer Co. is considering a proposition looking to the construction of sewage disposal works.

FLEMINGTON, N. J.—Plans for a system have been prepared by Focht & Herbert, Bound Brook; estimated cost, \$37,432.

JERSEY CITY, N. J.—Bids are asked until Sept. 11 for 3,400 lin. ft. 30-in. and 850 lin. ft. 24-in. brick sewer, 2,500 cu. yds. rock excavation, and for 770 lin. ft. 18-in. oval brick sewer, 500 cu. yds. rock excavation. George I. Bouton, Clk. St. Comrs.

ERIE, PA.—Bids are asked until Aug. 31 for 18 and 15-in. tile sewers. E. J. Morton, Acting Cy. Engr.

HOMESTEAD, PA.—Bids are asked until Aug. 26 and 620 lin. ft. 39-in. brick sewer, 1,310 lin. ft. 42-in. and 620 lin. ft. 39-in. brick sewer, and for 24 to 10 in. pipe sewers. Elmer Hough, Engr.

MILTON, PA.—The Milton Sewer & Drain Co. has been incorporated by Charles H. Dickerman, Marshall Reid and others; capital stock, \$1,000.

YORK, PA.—The mayor has recommended that a loan be made for the completion of the system.

HUNTINGTON, W. VA.—Five contracts for brick sewers have been awarded to H. L. Wright, aggregating \$26,961, and two to H. C. Shump, at \$1,873. Leete & Williams, Engrs.

DAYTON, O.—Bids are asked until Aug. 28 for a 36-in. brick to 12-in. pipe sewer in Germantown St. C. A. Herbig, Cy. Com.

MARTIN'S FERRY, O.—Bids are asked until Aug. 29 for 18 to 8-in. pipe sewers. F. Allender, Cy. Clk.

TOLEDO, O.—Bids are asked until Aug. 28 for three 24 to 20-in. brick sewers and one 15-in. pipe sewer. Sylvester Lamb, Cy. Clk.

ELKHART, IND.—Ordinances are being considered for several pipe sewers.

ANN ARBOR, MICH.—Bids are asked until Oct. 2 for \$30,000 of sewer bonds. Wm. J. Miller, Cy. Clk.

DANVILLE, ILL.—The council has passed an ordinance providing for the construction of the Jarred's branch brick sewer; estimated cost, \$20,000.

MADISON, WIS.—Engineers are invited to submit plans within 30 days for disposal of sewage by chemical precipitation. M. C. Dodge, Cy. Engr.

RACINE, WIS.—Bids for 15 to 8-in. pipe sewers in four streets have been rejected as being too high.

DAVENPORT, IA.—Resolutions have been adopted for sewers in several streets.

SAN ANTONIO, TEX.—The council has contracted for plans for a system.

OAKLAND, CAL.—The city engineer has reported that the proposed sewer east of Lake Merritt will cost about \$72,880.

NAPANEE, ONT.—An election will be held to vote on an issue of bonds for \$20,000 for sewers.

WATERLOO, ONT.—It is reported that the citizens will soon vote on a proposition to issue bonds for \$16,000 for a system.

STREETS.

NASHUA, N. H.—The aldermen have passed a resolution appropriating \$31,000 for highways and bridges.

NEW HAVEN, CONN.—A petition is being circulated for the extension of Third St.

TUCKAHOE, N. Y.—The council has awarded contracts as follows: Pennel & O'Hern, macadamizing 15,000 sq. yds. on the Tuckahoe road, at \$15,000, and macadamizing Yonkers Ave., at \$24,097; V. F. Smith, paving Palisade Ave., at \$32,000.—An issue of \$50,000 of street improvement bonds has been ordered.

YONKERS, N. Y.—The mayor will receive bids until Sept. 1 for \$50,000 of street improvement bonds.

JOHNSTOWN, PA.—The council has passed an ordinance providing for a loan of \$25,000 for paving, etc.

LANCASTER, PA.—The street commissioner has been instructed to advertise for bids until Aug. 29, for paving Marion St. with brick.

MORRISTOWN, PA.—Bids are asked until Aug. 30 for paving DeKaib St. from Elm St. to Basin St. with vitrified brick or asphalt blocks. William Vaughan, Chm. St. Com.

OSBORN, PA.—Bids are asked until Aug. 25 for excavating, building retaining walls, grading, filling, and for about 12,500 sq. ft. brick or flagstone pavement. W. J. Prentice, Chn. St. Com., 1009 Liberty St., Pittsburg.

PHILADELPHIA, PA.—The Alcatraz Paving Co. has been incorporated by William J. Latta, P. P. Bowders and H. M. DuBois; capital stock, \$10,000.

WILLIAMSPORT, PA.—It is reported that bids will be asked at once for paving Third St. with asphalt.

RICHMOND, VA.—The street committee has voted to pave several streets. A resolution is being considered appropriating \$50,000 for street improvements.

DAYTON, KY.—John Trapp has been awarded a contract for macadamizing three avenues in the Fort Thomas Land Co.'s property, at \$19,000.

BOND HILL, O.—Plans have been prepared for the improvement of Murray road.

CINCINNATI, O.—The contract for paving Hollister St. with brick has been awarded to C. N. Danenhow, at \$11,053, and that for macadamizing Ingleside Ave. to M. Crowley, at \$5,248.

DEFIANCE, O.—Thomas McKinney, Toledo, is reported as the lowest bidder for paving three streets with brick at about \$27,000.

HAMILTON, O.—Bids are asked until Aug. 29 for improving Shillito St. J. J. McMaken, Cy. Clk.

TEFFIN, O.—Bids for paving North Washington St. ranged as follows: With Hallwood blocks, \$25,694 to \$30,139; Canton shale, repressed, \$24,212 to \$26,121; Canton shale, standard, \$23,810 to \$25,718.

TOLEDO, O.—The only bid for paving Lincoln Ave. with asphalt was that of the Warren-Scharf Asphalt Paving Co., at \$22,324 with Berea, or \$22,869 with Medina curb.

EAST ST. LOUIS, ILL.—The council has decided to grade, pave and sewer Pennsylvania Ave., at an estimated cost of \$30,423.

MONMOUTH, ILL.—Commissioners have been appointed to assess a special tax for the proposed improvement of 1,746 lin. ft. of West Broadway.

MADISON, WIS.—The council has voted to issue street improvement bonds for \$15,000.

ST. CHARLES, MO.—Bids will be received until Sept. 29 for about \$12,000 sq. yds. paving with vitrified brick, 5,000 lin. ft. curbing to be reset and 5,000 cu. yds. extra grading; estimated cost, \$17,500. H. C. Sandfort, Cy. Clk.

DENVER, COLO.—The board of public works has voted to pave Larimer St., 22,080 lin. ft.; estimated cost, \$128,745.

TACOMA, WASH.—Bids are asked for paving Pacific Ave. with bituminous rock; estimated cost, \$70,000.

ELECTRIC LIGHT AND POWER.

LACONIA, N. H.—Bids are asked until Sept. 1 for 80 or more electric lights for five years; separate bids to be received for 1,200 and 2,000-c. p. lights and for lights to burn till one o'clock and all night. Benj. F. Drake, G. W. Weeks and H. W. Correll, Com.

EVERETT, MASS.—The committee has been requested to investigate the question of a municipal electric light plant.

FLATBUSH, N. Y.—The Flatbush Electric Light & Power Co., to which a franchise was recently granted, is negotiating for the erection of its plant.

BORDENTOWN, N. J.—The council is considering a proposition for the erection of a plant for both arc and incandescent lighting.

CANNONBURG, PA.—Ed Pare and Thos. J. Pare, Pittsburg, are reported as interested in a proposed electric light plant at this place.

FOREST CITY, PA.—A franchise has been granted to the Forest City Light Heat & Power Co., the plant to be constructed within nine months.

BALTIMORE, MD.—R. Jerome Alken is organizing the Domestic Light & Power Co., according to reports; capital stock, \$50,000.

PAW PAW, MICH.—Electric light bonds for \$15,000 have been sold. Water power will be used to generate the electricity.

HASTINGS, NEB.—The Hastings Electric Light Co. has discontinued its service to the city, and it is stated that the city may put in a municipal plant in connection with the water-works.

BERKELEY, CAL.—The contract for electric street lighting for one year has been awarded to the Oakland Gas Light & Heat Co., at \$114 per light, each light to burn until half-past one o'clock and on all dark nights.

NEW COMPANIES.—Altmeyer Electric Light, Heat & Power Co., McKeesport, Pa.; \$30,000; Geo. Altmeyer, John Oliver, J. P. Mill.—Atwood Electric Headlight Co., St. Louis, Mo.; \$125,000; C. Atwood, E. B. Roth, M. Keber.—St. Charles Light & Fuel Co., St. Charles, Mo.; \$20,000.—Las Animas Light, Power & Mfg. Co., Denver, Colo.; \$100,000.

CONTRACT PRICES.

WATER-WORKS SUPPLIES.—Newnan, Ga.—Separate bids on material were received as follows, prices being f. o. b. cars in this city: Pipe, \$21 to \$22.50 per ton; lead, \$4.05 to \$4.75 per cwt.; hydrants, \$20.80 to \$25 each. The total bids received for water-works with notice of award of contract were published last week. N. Wilson Davis, Engr., Atlanta.

DREDGING.—Albany, N. Y.—The contract for dredging the Albany basin, about 70,000 cu. yds., has been awarded to P. W. Myers, at 17 cts. per cu. yd. The dirt will have to be towed about five miles down the river. Other contracts were awarded as follows: I. T. Brown, New York, dredging channel at Cossackie, 35 cts. per cu. yd.; P. W. Myers, Albany, dredging at Stuyvesant, 28 cts. per cu. yd.; Kingston & Woods, Buffalo, deepening and improving Black Rock Harbor and Erie basin, \$20,380.

CONDUITS.—Detroit, Mich.—The public lighting commission opened bids Aug. 16 for constructing the main lines of the conduits, the work being as follows: 1, 36-duct, 400 lin. ft.; 2, 16-duct, 2,570 lin. ft.; 3, 9-duct, 9,900 lin. ft.; 4, 6-duct, 2,950 lin. ft.; 5, man-holes, 65. The prices were as follows:

	1.	2.	3.	4.	5.
Patrick McCoy.....	\$2.65	\$1.57	\$1.26	\$1.16	\$51.00
Liphart & Winterhalter	1.35	1.00	0.85	0.75	55.00
R. Collins & Co.....	8.82	4.62	3.10	2.40	60.00
Henry Collins.....	2.19	1.75	1.49	1.16	75.00
C. B. Cole.....	2.09	1.41	1.08	0.95	47.15
Wilson & Jackson....	1.88	1.15	0.89	0.71	69.00

RESERVOIRS.—Portland, Ore.—The lowest bid for a reservoir in the Grove tract was that of J. R. O'Neill, as follows: Earth excavation, 36,000 cu. yds., at 30 cts.; rock excavation, 6,000 cu. yds., 40 cts.; loose rock, 1,000 cu. yds., 50 cts.; hard pan, 1,000 cu. yds., 85 cts.; total, \$14,550. The other total bids were: J. S. Antonelle, Portland, \$14,990; Oscar Huber, Spokane, \$15,500; W. J. Schmidt, Berkeley, Cal., \$18,430; Geo. Mansen, Portland, \$18,690; Pacific Bridge Co., Portland, \$19,500; E. W. Everett, Portland, \$21,600. Mr. O'Neill was also the lowest bidder for the reservoir at Mount Tabor, as follows: Earth excavation, 38,000 cu. yds., at 18 cts.; rock, 1,000 cu. yds., 35 cts.; loose rock, 1,000 cu. yds., 35 cts.; hard pan, 2,000 cu. yds., at 40 cts.; total, \$8,340. Other bids for this work being W. J. Schmidt, Berkeley, Cal., \$13,640; Peter McCubben, Portland, \$13,960; Oscar Huber, Spokane, \$14,050; Pacific Bridge Co., Portland, \$14,710; C. W. Everett, Portland, \$17,350; Hamilton & Howard, Portland, \$18,550.

MISCELLANEOUS.

DITCH.—Marion, O.—Plans have been prepared for a ditch for the relief of Goose Creek; estimated cost, \$15,388.

GRAIN ELEVATOR.—Winnipeg, Man.—It is reported that the Canadian Pacific Ry. will soon construct a large grain elevator in this city.

BONDS.—Hamilton, Ont.—Bids will be received until Oct. 4 for the purchase of \$2,350,000 of 40-year 4½ bonds, interest paid semi-annually. A. Stuart, Cy. Treas.

COURT HOUSE.—Oglethorpe, Ga.—Bids are asked until Oct. 3 for the erection and completion of the Macon county court house. W. Chamberlin & Co., architects, Knoxville, Tenn. J. D. Frederick, Chn. Co. Comrs.

DAM.—Atlanta, Ga.—It is stated that engineers representing Massachusetts capitalists have been in the city several days studying the Chattahoochee River with a view to constructing a dam just below the new water-works.

FORT ENLARGEMENT.—Denver, Colo.—Capt. M. C. Martin has been instructed to advertise for bids for the erection of one double company house and two double sets of officers' quarters at Fort Logan; estimated cost, \$70,400.

IRON AND STEEL WORK.—Washington, D. C.—The contract for iron and steel work on basement and first floor of the city post office has been awarded to John Pierce, New York, at \$57,790. He has the contract also for the superstructure.

LEVEES.—Memphis, Tenn.—Bids will be received at the U. S. Engineer Office until Sept. 1 for the construction of levees in the upper Tensas levee district at Salina Plantation, on the Cypress Creek line, and at Mathews Bend, 508 miles below Cairo. Capt. C. McD. Townsend, U. S. A.

STEEL RAILS.—Ottawa, Ont.—Bids are asked until Sept. 12 for steel rails as follows: 1,000 tons 50-lb., to be delivered at Summerside, Prince Edward Island; 300 tons 56-lb., at Richmond (Halifax), N. S.; 5,000 tons 67-lb., at Levis, opposite Quebec. Jno. H. Balderston, Secy. Dept. Ry. and Canals.

BUILDING MATERIAL.—Chicago, Ill.—Bids will be received at the office of M. E. Bell, architect, 125 Hartford Bldg., until Sept. 2, for building material, including stone, brick, cement, iron, steel, lumber, slate and millwork, necessary to construct the boiler and power house, trade school building, hospital, barn and icehouse at the Illinois State Reformatory at Pontiac. Samuel Fallows, Pres. Bd. Mgrs.

TIMBER, GRANITE, ETC.—New York, N. Y.—The department of docks will receive bids until Aug. 30 for about 1,597,535 ft. B. M. sawed yellow pine timber, and until Sept. 5 for granite stones for bulkhead or river wall, 1,314 pieces of granite aggregating 33,119 cu. ft.; and a new dumping-board on pier 42, North

River, the work requiring about 85,385 ft. B. M. yellow pine timber, 9,680 ft. B. M. spruce timber, 12,917 lbs. wrought iron spikes, bolts, etc.

PIPE LINE.—Huntington, W. Va.—Leete & Williams, of this city, are making preliminary location surveys for a pipe line about 40 miles long, to be laid by the Natural Gas Co. of West Virginia, headquarters at Pittsburg. The line is to extend from the Warfield gas region on the Big Sandy River to Central City and when completed will furnish natural gas to this city, Central City, Catlettsburg and Ashland, Ky., Tronton, O., and other neighboring river towns.

FERRY SLIPS.—San Francisco, Cal.—The harbor commissioners have awarded the contract for constructing slips 5 and 6, at the foot of Market St., to G. W. Stewart, Gen. Man. Pacific Pine Lumber Co., at \$43,980, the other bids being as follows: San Francisco Bridge Co., \$47,500; Doe, Hunt & Co., \$52,870; Darby, Laydon & Co., \$48,700; California Cons. Co., \$44,444; B. McMahon & Son, \$48,950; Healy, Tibbetts & Co., \$50,300. The lowest bid at a previous opening of bids was \$48,945, and all were rejected; engineer's estimate, \$43,200.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, have a contract for 18 six-wheel engines for the New York, Lake Erie & Western, to be delivered before Jan. 1.

The Richmond Locomotive Works, Richmond, Va., have a contract for five 8-wheel passenger engines and one 6-wheel freight engine for the Port Royal & Augusta, to be delivered next month.

CARS.—The Ohio Falls Car Co. has a contract for a lot of passenger coaches for the Louisville, Evansville & St. Louis, and the New Albany, Ind., "Ledger" states that the price is \$1,000 per car less than for a similar car last year.

The Seaboard Air Line shops at Portsmouth, Va., have recently built 39 furniture cars, capacity 60,000 lbs., for the Elliott Furniture Co., Charlotte, N. C.

The Sheffield Car Co., Three Rivers, Mich., has recently shipped an invoice of cars to parties in Florida for use in phosphate mines. They are constructed on a plan heretofore unused in this class of industry, dumping in the center of track instead of at the sides or ends. Parties having these cars report themselves as highly pleased.

FLEXIBLE PIPE JOINTS.—The Falcon joint, for water pipe, described in our issue of June 8, 1893, has been adopted by the city of Vicksburg, Miss., and 30 of these joints are being put in on the new water-works intake pipe of the Washburn & Moen Wire Works, Waukegan, Ill. It is 16 ft. long, and 7 ft. in diameter, and is the largest strainer ever built. It was described in our issue of March 3, 1893.

JOSEPH G. FALCON, Evanston, Ill., has completed his contract for putting a Falcon rotary strainer, for protection against ice, dead fish, etc., on the 30-in. water-works intake pipe of the Washburn & Moen Wire Works, Waukegan, Ill. It is 16 ft. long, and 7 ft. in diameter, and is the largest strainer ever built. It was described in our issue of March 3, 1893.

THE LAIDLAW-DUNN-GORDON CO., Cincinnati, reports that its water-works business is exceedingly good, considering the financial depression, having contracted during the past month to furnish pumping engines as follows:

Union City, Ind., one engine, capacity 1,500,000 gallons	
La Grange, Ind., two engines, " each 750,000 "	
Stebensburg, O., one engine, " 1,000,000 "	
Norwood, O., " " 1,000,000 "	
Huntingburg, Ind., " " 1,500,000 "	
Greeley, Colo., " " 1,500,000 "	
Rome, Ga., two engines, capacity each 2,000,000 "	
Logansport, Ind., one engine, capacity 3,000,000 "	
Hillsboro, O., two engines, " each 1,000,000 "	

The contract at Norwood, O., includes four deep wells, and that at Hillsboro, O., is conditional upon the sale of bonds by the city.

NEW COMPANIES.—Gaffney Vitrified Brick Co., Kansas City, Kan.; \$80,000. John Gaffney, Jas. Nolan, Atchison; S. N. Simpson, E. S. Eckart, Kansas City. Hidaige Surveying Co., Chicago, Ill.; \$100,000. D. Warner, P. Hatch, M. E. Miller. McKinney Wharf Co., McKinney, Tex.; \$25,000; J. L. White, J. L. Heard, Jesse Shain. Allegheny Foundry Supply Co., Chicago, Ill.; \$50,000; S. Griffiths, A. E. Corey, J. M. Marsh. Bothwell Compressed Air Improvement and Construction Co., New York, N. Y.; \$5,000. Du Bois Pressed Brick Co., Marion, Ind.; \$40,000. Colorado Contracting Co., Denver, Colo.; \$20,000. Extension Car Step Co., Utica, N. Y.; \$100,000. Central Construction & Equipment Co., Chicago, Ill.; \$200,000; constructing and equipping railways.

STORAGE RESERVOIR.

Sealed proposals, addressed to the City Clerk, will be received by the City of Galesburg, Ill., until 12 o'clock noon, August 28th, 1893, for furnishing all labor and materials necessary to construct and complete a storage reservoir for said city, according to plans and specifications on file in the office of the City Clerk. Proposals will be received for the whole or separate portions of the work. Approximate quantities upon which bids will be compared are as follows: 12,000 cubic yards of earth-work, 1,000 cubic yards of concrete, 150 cubic yards brick masonry, 700 lineal feet of 16-inch cast iron pipe, 350 lineal feet of 15-inch vitrified sewer pipe, 150 lineal feet of 24-inch vitrified sewer pipe, 2,000 feet of B. M. pine lumber, two 16-inch check valves, ten 16-inch gate valves, six 8-inch gate valves and two sluice gates.

The right is reserved to reject any or all proposals.
J. C. STEVENS,
33-2t City Clerk.

Proposals for Excavating.

SANITARY DISTRICT OF CHICAGO. —TO CONTRACTORS.

Sealed proposals addressed to the Board of Trustees of the Sanitary District of Chicago and indorsed

"Proposal for Excavating a Portion of the Main Drainage Channel" will be received by the Clerk of the said Sanitary District at Room H, Rialto Building, Chicago, Ill., until 12 m. (standard time) of Wednesday, the 4th day of October, 1893, and will be publicly opened by the said Board of Trustees at the regular meeting held that day or at a special meeting called for that purpose.

The work for which the said tenders are invited is the excavation of that portion of the main drainage channel for the said Sanitary District, between Willow Springs and Joliet, Ill., known as contract sections two (2), three (3) and four (4), and consists in all of about 1,484,800 cubic yards of rock, of about 2,179,500 cubic yards of earth, the building of about 76,466 cubic yards of dry rubble walls.

Each of said sections will be treated as a separate contract in canvassing the proposals and making awards. As all awards will be made by individual sections, each bidder must make prices for each section separate and distinct from every other.

Each proposal must be accompanied by a certified check or cash to an amount equal to \$3,000, multiplied by the number of sections bid upon.

All certified checks must be drawn on some responsible bank doing business in the city of Chicago, and be made payable to the order of the Clerk of the Sanitary District of Chicago. Said amount of \$3,000 for each section will be held by the Sanitary District until all of said proposals have been canvassed and contracts awarded and signed, the return of said check or cash being conditioned upon any bidder to whom an award of any portion of said work may be made appearing within ten days after notice of such award being given, with bondsmen, and executing a contract with the Sanitary District for the section or sections of said work so awarded, and giving a bond satisfactory to said Board of Trustees for the fulfillment of the same in the amount of \$100,000 for each section of work awarded him.

All proposals must be made upon blank forms furnished by the Sanitary District and must give the price for each separate item of work.

The bids will be compared on the basis of the engineer's approximate estimate of quantities, which will be furnished with copies of the specifications.

No proposal will be considered unless the party making it shall furnish evidence satisfactory to the Board of Trustees of his ability to do the work, and that he has the necessary pecuniary resources to fulfill the conditions of the contract, provided such contract shall be awarded him.

Bidders are required to state in their proposals their individual names and places of residence in full.

Specifications and plans may be seen at the office of the Chief Engineer, Rialto Building, Chicago, Ill.

The said Board of Trustees reserves the right to reject any and all bids.

THE SANITARY DISTRICT OF CHICAGO,
By FRANK WENTER,
President of its Board of Trustees.
Attest: THOMAS F. JUDGE, Clerk.
Chicago, Ill., Aug. 5, 1893. 32-8t

SEALED PROPOSALS WANTED.

Sealed offers to purchase Thirty Thousand Dollars of the bonds of the city of Ann Arbor, State of Michigan, will be received by the City Clerk at any time on or before the first Monday of October next, at twelve o'clock, noon.

These bonds are to be sold for the purpose of raising money to enable the city to construct a main sewer, and they were authorized by a special act of the legislature and a vote of the people, and will draw interest from date of issue at 5 per cent. per annum, payable at the City Treasurer's Office. The principal will mature in yearly installments of Two Thousand Dollars and are a charge upon the whole city. The said bonds will not be sold for less than face value, and the right to reject all bids is reserved.

By order of the Common Council.
WILLIAM J. MILLER,
City Clerk.

PROPOSALS FOR PLATTING THE CITY OF NEW BEDFORD, MASS.

Surveyors and engineers are invited to offer bids for platting the territory of the City of New Bedford for the purposes of the assessment of taxes. The system to be similar to that used in the City of Woonsocket, Rhode Island. Total area of city about twenty square miles.

Population, 50,000. Scale, 60 feet to the inch. Printed specifications will be furnished upon application to Lemuel Le B. Holmes, Esq., Secretary of Special Committee of the City Council. No bids will be received after September 1st, A. D. 1893. The Committee reserves the right to reject any and all bids. 30-5t

ELECTRIC LIGHT AND WATER- WORKS.

NOTICE TO CONTRACTORS.

Sealed proposals will be received by the Treasurer of the City of Harrison, Tenn., until Sept. 1st, 12 m., 1893, for the construction and completion of the whole or parts of an electric light plant and water-works, in accordance with the plans and specifications now on file in the office of the City Engineer.

Instructions to bidder and blank forms for bids, plans, specifications, etc., will be furnished to bidders on application made to the City Engineer.

The city reserves the right to reject any and all bids.

Bids shall be made on the basis of payment in the bonds of the city at par, and also in cash.

A. W. BURR,
31-4t City Treasurer.

U. S. ENGINEER OFFICE, Army Building, New York, July 24, 1893.—Sealed proposals for removing 260,000 cubic yards, more or less, of material, mud, earth, ledge rock, broken stone, old timber, etc., from the Harlem River, Spuyten Duyvil Creek, and from the dams inclosing the cut through Dyckman Meadow, on the line of the Harlem River improvement, and for furnishing the materials and workmanship for the construction of revetments for slopes of the sections excavated, will be received at this office until 12 o'clock noon, Aug. 24, 1893, and then publicly opened. Specifications, blank forms and all available information will be furnished on application to this office. G. L. GILLESPIE, Lieut.-Colonel, Corps of Engineers. 31-4t

PROPOSALS FOR SEWER CON- STRUCTION.

City Clerk's Office,
Utica, N. Y., Aug. 17, 1893.

To Contractors: The Common Council of the city of Utica, N. Y., will, on Friday morning, September 1, 1893, open proposals for the construction of the Hotel street trunk sewer (so called). The sewer commences at the Mohawk River, runs through Division street and Water street to Hotel street, thence to the south side of the Erie Canal, with a lateral sewer from Hotel street, through Water street, to Griffith's place.

The dimensions of the sewer are as follows:

Plan No. 1: 870 lineal feet of brick sewer, 8 feet chord, with an area of 43 square feet.

Plan No. 2: 720 feet of brick sewer, 6½ feet in diameter.

Plan No. 3: 1,090 feet of brick sewer, 4½ feet in diameter.

Plan No. 4: 100 feet of brick sewer, 4½ feet in diameter, under the Erie Canal.

In addition, a bulkhead of dressed masonry at the Mohawk River, and the masonry manholes with clutch basins, as shown on the plan on file in the City Clerk's office.

A certified check for ten per centum of the estimated cost of the work—\$52,000—will be required to accompany each proposal; also a bond in the penalty of \$50,000 for the faithful performance of the contract.

For further information apply to
CAMPBELL W. ADAMS, City Surveyor.
P. J. McQUADE, City Clerk.

34-1t

NOTICE TO BUILDING CON- TRACTORS.

Sealed bids for building a Court House at Clarksdale, Coahoma County, Miss., according to the plans and specifications now on file in the office of the Chancery Clerk, of Coahoma County, at Clarksdale, and also in the office of Jas. B. Cook, Architect, Memphis, Tenn., will be received by the Board of Supervisors of said county, at Friars Point, in said county, on Monday, the 4th day of September, A. D. 1893.

No bids will be considered unless accompanied by a certified check for \$250, payable to the Board of Supervisors of Coahoma County, Miss., as a forfeit in case the contractor, whose bid is accepted, should fail to give a satisfactory bond.

JAS. A. SUDDOTH, Clk.
34-1t